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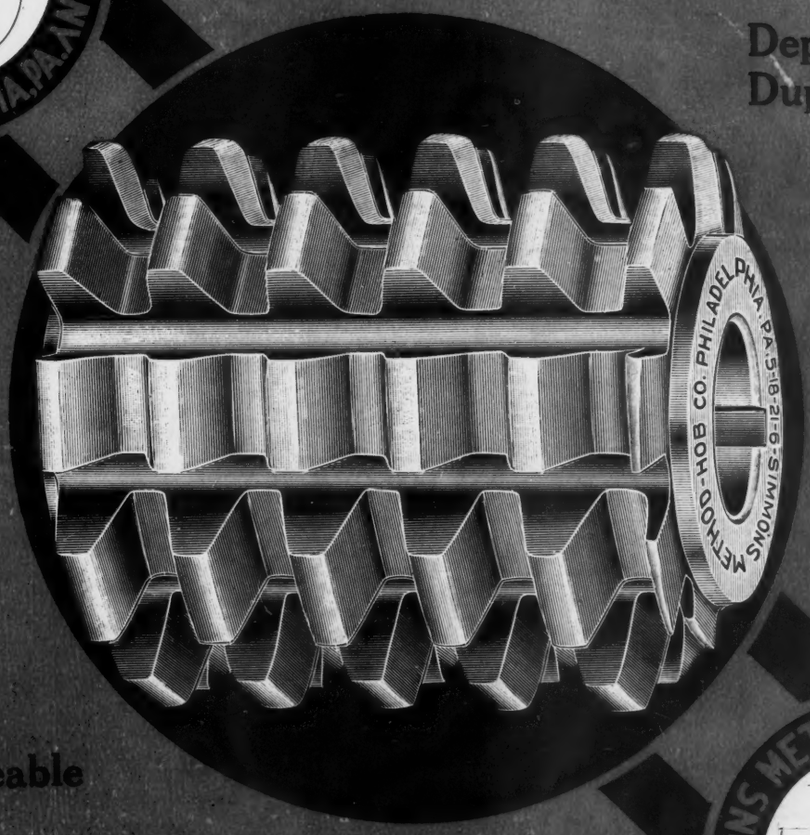

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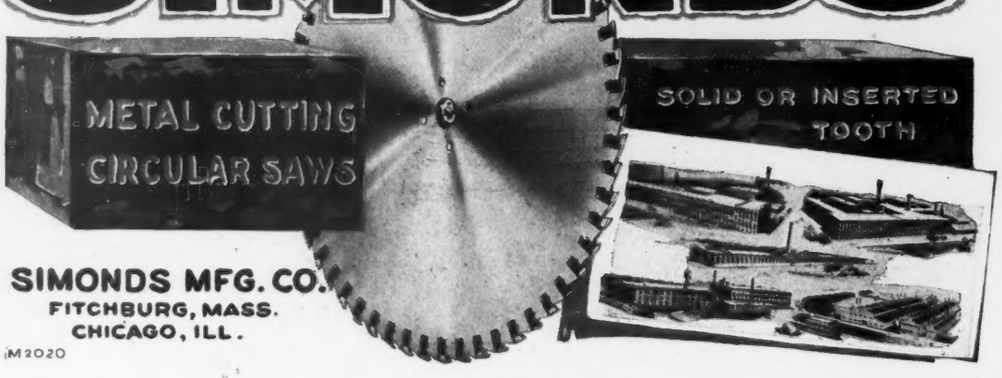

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SEPTEMBER MACHINERY 1921

Cutting Rolling Mill Driving Gears

Producing Large Herringbone Gears by the End-milling Process at the Woodard Machine Co.'s Plant in Wooster, Ohio

By FRED R. DANIELS

THE service required of transmission gearing in steel rolling mill machinery demands that the gears be so designed and machined that they will withstand the heavy loads and severe stresses encountered, and at the same time have a smooth action in which the meshing teeth will have a continuity of engagement. This type of smooth-action transmission has been approximated by what is known as "stepped" gearing, in which two gears are placed side by side on a shaft, with the teeth of one member opposite the spaces in the other.

It was soon recognized that the best type of transmission was the double helical or herringbone gear drive, but the difficulty that has usually been experienced in the machining of this type of gear has been one of the greatest hindrances to its more general use. When the herringbone gear is made in two parts, each being a helical gear of opposite hand to the other, the teeth may be cut by any convenient means and the halves securely fastened together after cutting. Modern developments in helical gear cutting, however, have made it possible to cut what is known as the Wuest type of herringbone gears by hobbing, running the cutter past the center where the teeth of opposite helical angles meet. One-piece herringbone gears may be cut in this manner without encountering the difficulties that formerly restricted the use of herringbone gear transmissions. In the Wuest type of gear, the teeth on opposite sides of the center line are staggered an amount equal to one-half the circular pitch.

The present article describes the method of cutting a one-piece herringbone gear by end-milling and without staggering the teeth of opposite halves of the gear. A special form of end-mill is used, and the teeth on one half of the gear are completely cut before the position of the gear is reversed to cut the teeth on the opposite half. The equipment employed is illustrated in Figs. 2, 3, and 4.

Objections to the End-milling Process

A number of objections have been raised to the practice of cutting teeth by the end-milling process, one of which is

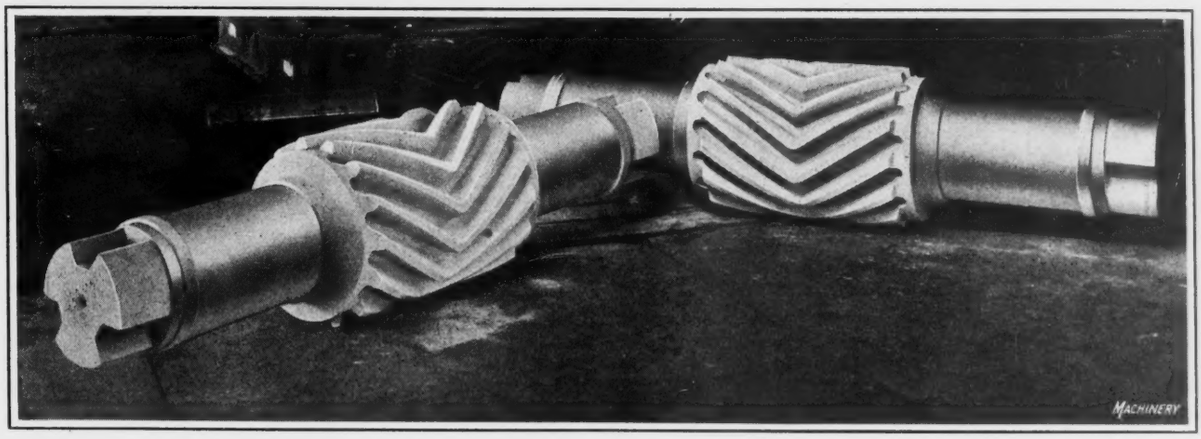


Fig. 1. Semi-shrouded Rolling Mill Herringbone Pinions machined by end-milling

that the flutes of the cutter become clogged with chips, resulting in the tool becoming overheated. Another objection frequently brought forth is that the tool is so comparatively small that the cutting edges are subjected to excessive wear, the result being an incorrectly formed tooth. These objections, it will be seen, can be overcome. The end-milling process is the only one by which integral shrouded or semi-shrouded herringbone gears can be machined satisfactorily. It may be that this fact accounts for the amount of research which the Woodard Machine Co., Wooster, Ohio, has put forth in developing a method for end-milling these heavy gears that would produce entirely satisfactory results and that would withstand the arguments that have been advanced against the use of the end-milling process for machining gear teeth.

The obvious purpose of shrouds and half-shrouds is to furnish added strength, and on straight-toothed gears to eliminate end play of gear and pinion. For shrouded herringbone gears, the end-milling process is the only one practicable. Although the helix angle generally used for herringbone gears is 23 degrees, gears having greater helix angles than this, up to 45 degrees, are conveniently cut by the end-milling process, and an angle of about 30 degrees has proved very satisfactory.

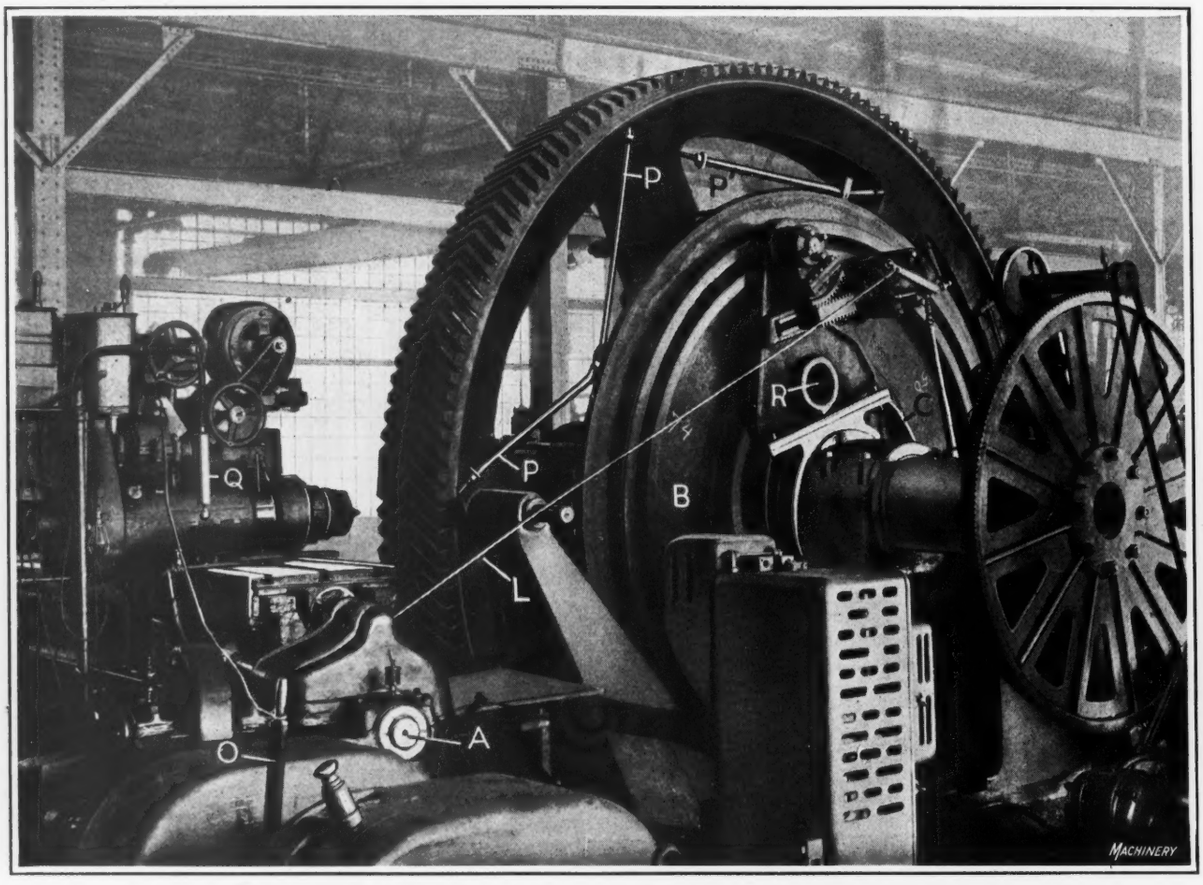


Fig. 2. Set-up of Machine used in end-milling the Teeth in Large Herringbone Driving Gears

Cutting Teeth in a Steel Mill Driving Gear

The practice in the shop of the Woodard Machine Co., in machining rolling mill machinery transmission gears, is to plane gears having a circular pitch of more than 5 inches and to end-mill those of less circular pitch. This article will cite two examples of finishing rolling mill transmission gears, one employing the end-milling process, and the other using the planing method. It is claimed that the objections commonly raised to the use of an end-mill for cutting gear teeth have been overcome by designing the tool so that it has a special form. Fig. 2 shows one view of the machine used in end-milling a 15-foot driving gear for one section of a 12-inch continuous strip mill. In service, this gear transmits a normal load of about 600 horsepower through a pinion, the ratio of the gear to the pinion being 8 to 1. The gear has 160 teeth, 20-inch face, a helical angle of 30 degrees, and a circular pitch of 3.534 inches. The teeth are not cast, but are cut from a solid blank in two operations. The gear is a steel casting with a carbon content of 0.35 to 0.45 per cent.

The planer style of table and the worm-gearing for revolving the gear are driven by a 25-horsepower reversing motor, the transmission of which is shown in the foreground. The table is driven by a rack meshing with a worm on the drive shaft, the end of which is shown at *A*. This shaft is set at an angle with the direction of travel of the planer table. It is driven through spiral and bevel gearing by a secondary drive shaft. This secondary drive shaft may be driven directly by the motor, when the planing process is used, or through the reduction transmission and selective speed gearboxes when a slow feed is required for the milling process. This secondary drive shaft also drives, through gearing and helical change-gears, splined shaft *S*, Fig. 4, which actuates the worm by means of which the spindle and faceplate are rotated. The speed may be varied for machining gears of different diameters by selecting suitable change-gears for driving worm-shaft *S*. The worm drives the faceplate by means of a sector arm *D*, Fig. 3, attached to the lower side of collar *C*.

Air-operated Clamping Device

The locking arrangement by means of which the faceplate is released during the indexing of the gear is also shown in Fig. 3. This is a view from the rear of the machine, and gives a good idea of how the indexing and clamping of the work are accomplished. On the upper slab portion of the collar *C* is bolted an extension arm *E*, which carries an air cylinder *G*, the piston of which is extended in the form of a double-sided rack *F*, which rides in a suitable slide.

At the extreme end of this extension arm there is an arm *H* which carries a segment. The segment arm *H* is fitted with a bronze nut which, acting on the thread of bolt *I*, draws the square head of the bolt which rests in the circular T-slot *J* in faceplate *B*, up against flanges in the faceplate slot, thus securely locking the faceplate to the oscillating worm. This is accomplished by air cylinder *G* acting on segment arm *H* through rack *F*.

After the faceplate has thus been locked to the drive shaft, the worm and sector arm *D* may be engaged so as to rotate the gear past the cutter the amount demanded by the angularity of the teeth, which in this case is tan 30 degrees (helix angle) × 10 inches (one-half face width), or approximately 5¾ inches. After machining each tooth, the faceplate is released by opening the air valve, and the indexing device is engaged. The lever that operates the air valve of the cylinder is connected by rod *L* to the operator's station, as may also be clearly seen in Fig. 2.

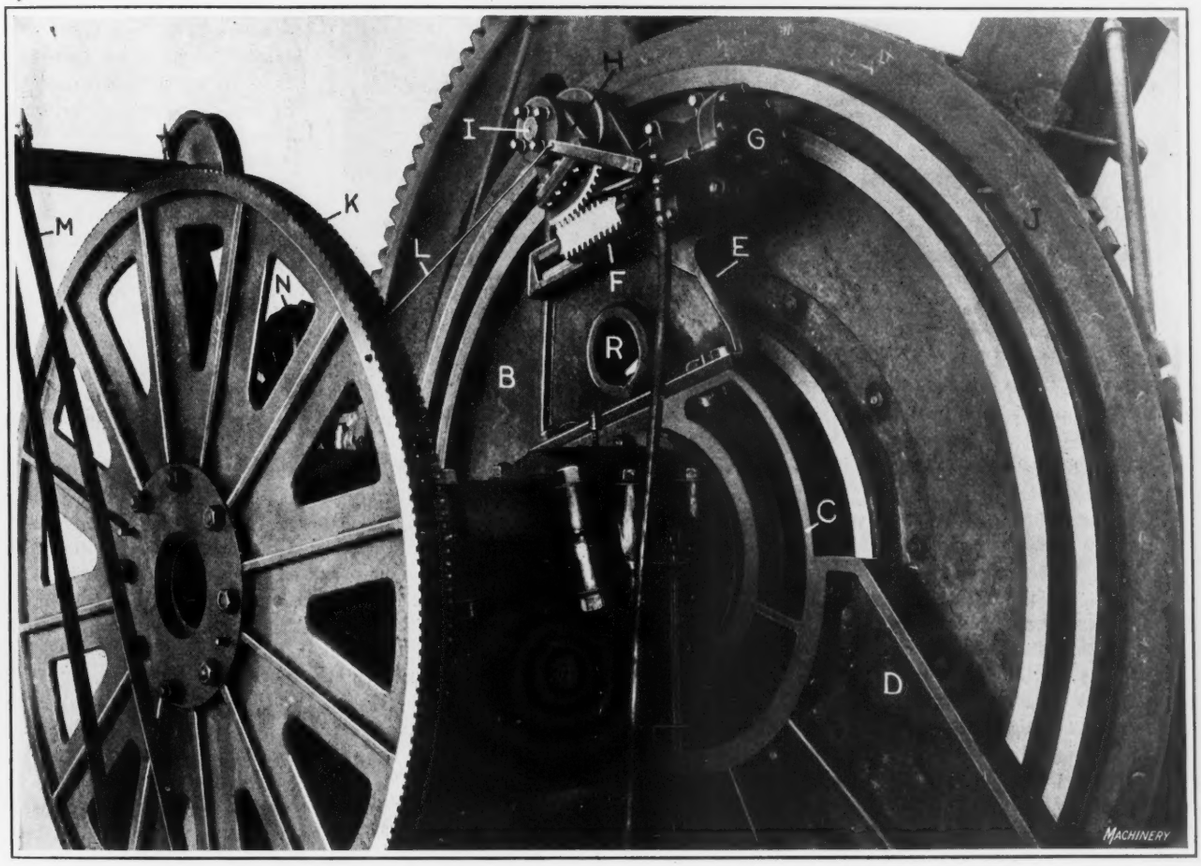


Fig. 3. Air-operated Device for clamping the Faceplate to the Driving Shaft of the Machine, and Indexing Mechanism

Indexing Mechanism

The indexing mechanism consists of a worm and a worm-wheel *K*, Fig. 3, and a slip pulley drive. The worm is carried on the lower end of an arm located adjacent to the inner side of gear *K*. The worm-shaft carries the slip pulley which is driven through a belt *M* from the pulley shown just above the worm-wheel, and the motor *N*, which also is attached to the previously mentioned arm and which oscillates with it during the operation of the indexing mechanism. The switch for the indexing motor is located at the operator's station, as are also all other controls for the feeds and speeds of the machine.

The pendent switch *Q*, Fig. 2, which controls the main motor, is furnished with a cable so that the power may be quickly reversed or switched off without requiring the operator to leave his station. The milling head is equipped with hand controls for the regulation of the cutter, and motors for rotating and feeding in the end-mill, as may be seen by referring to both Figs. 2 and 4. The latter illustration is a view from the opposite side of the gear and shows the type of end-mill used to better advantage. It will be noticed that a portable motor-driven grinding wheel *A* is located in a convenient position relative to the cutter-spindle, so that the end-mill may be dressed as it becomes dull. When grinding the cutter, the contour of the cutting edge is not touched by the wheel, the front clearance angle only being ground. Burrs produced by grinding the cutter may be smoothed off by lightly stoning the outer cutting edge, but not to such an extent that the contour of the cutter will be affected.

Reference to Figs. 2 and 4 will enable the method of attaching the work to the faceplate to be seen, as well as the use of auxiliary pipe-jack supports *P*, which withstand the turning moment in both directions and thus aid in assuring a positive drive for the gear. A support for the hub of the gear is provided by the swinging arm *D*, Fig. 4, which is clamped over the end of the gear hub by a turnbuckle screw, as shown. This arm carries a roll at *C*, so that the gear is not only free to revolve, but is also provided with a suitable outboard bearing.

Two cuts are required for machining these gears. In this particular instance, the cutter revolves at 210 revolutions per minute during the roughing cut and at 160 revolutions per minute while finishing the teeth. Although the speed of the cutter is decreased for finishing, the feed is the same in both operations, the rate being approximately 1½ inches per minute.

Sequence of Operations

The sequence of operations in machining a tooth on one side of the gear is as follows: The feed of the planer table is first engaged by means of the pendent switch *Q*, Fig. 2, which also results in revolving the faceplate and gear at the proper speed, as determined by the selection of the change-gears for the segment worm-shaft. In the present

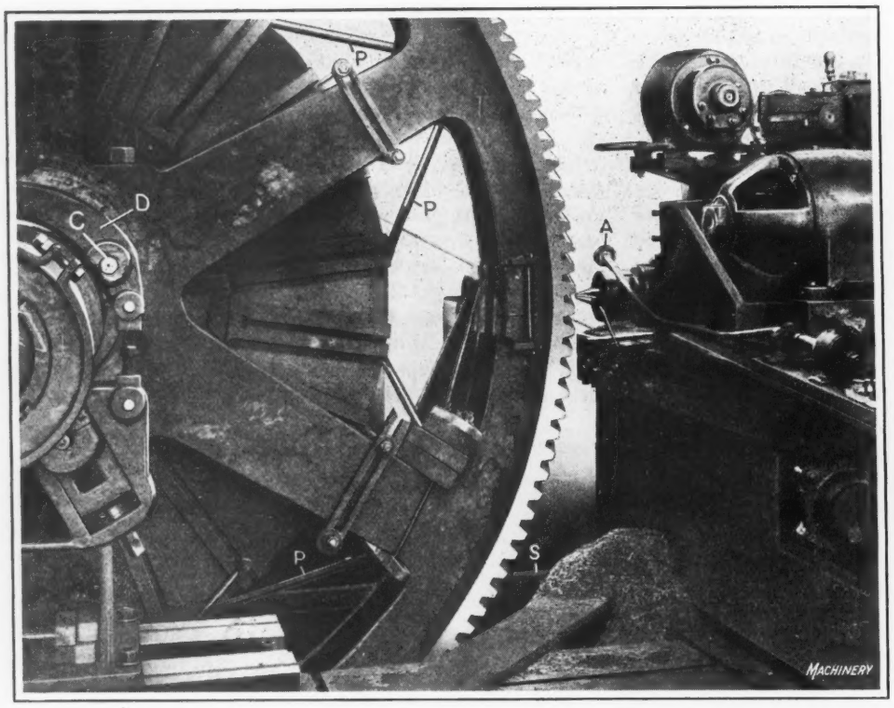


Fig. 4. Opposite Side of Gear illustrated in Fig. 2, showing the End-mill and the Method of attaching the Gear to the Faceplate

case, the gear ratio would be such as to rotate the gear a peripheral distance of approximately 5¾ inches while the table is feeding horizontally about 11½ inches. After the cutter has advanced to the center of the gear face, and the cut is completed, the driving motor is reversed, so that the end-mill travels back in the space just cut at a greatly increased speed, and the faceplate locking device oscillates backward in anticipation of the indexing movement. The motor that drives the cutter is then switched off, after which rod *L*, which controls the air cylinder valve, is operated to release the faceplate from the driving shaft of the machine. The indexing motor may then be switched on by means of the switch convenient to the operator's station. As soon as the faceplate has been indexed back a distance equal to the circular pitch, the air-operated segment-and-rack clutch is again engaged, the driving motor switch *Q* for traversing the planer table and rotating the faceplate, thrown in, the end-mill driving motor switched on, and the cut started.

After all the teeth on one side of the gear have been cut, the end-mill is moved to the opposite side and the operation continued. In Fig. 2, all the teeth on one side have been finished, and on the other side they have all been rough-cut except two. In the finishing operations, any inaccuracies in roughing are rectified, the tool used being of substantially the same design as that used in roughing.

For gears of smaller diameter the outer ring of the faceplate, which is attached with bolts, may be removed so that it will not be in the way, and the same segment gear *H*, bolt *I*, etc., (Fig. 3) are mounted in hole *R* and the opposite side of the rack is utilized.

Reference was made in the early part of this article to the particular advantage of the end-milling process where shrouded gears and pinions are to be cut. Although the gear shown in the illustrations referred to is not of the shrouded type, it is evident that cutting the teeth with semi-shrouds or full shrouds would not introduce any radical change in the machining procedure.

Planing Blooming Mill Pinions

The gear planer shown in Fig. 5 is the same type machine as shown in Fig. 2, except that the milling head has been replaced by a planer head, mounted on the same table. Here the work is a cast-steel gear, with a carbon content of 0.30 to 0.35 per cent, containing fifteen teeth of the stub involute form. The circular pitch is 7.33 inches, the helical angle, 25 degrees 25 minutes 21 seconds, the pitch diameter, 35 inches, and the width of face, 34 inches. It will be noticed that for this particular gear, a faceplate is not employed, a substantial collar *A* being used instead, in which one turned bearing end of the pinion enters and is secured by set-screws. The arrangement for indexing the pinion is the same as that previously described, except that the locking device is not used and a worm-wheel segment *B*, of shorter radius, takes the place of the large segment *D*, Fig. 3. The other end of the pinion is supported in a roller bearing having a swinging arm, roller, and turnbuckle arrangement which is similar to that employed in supporting the larger gear, as shown in the illustration Fig. 4.

Referring to the planer table, it will be seen that the tool-holder block *C* may be set at the proper angle to agree with the helix angle of the pinion to be cut, being rocked to the desired angle by means of segment gear *D* and handwheel *E*. The spring-operated clapper-box *F* is carried on the block *C*, which may thus be swiveled in the cradle fixture *G* in which it is carried, by means of gear *D*, as already stated. The arrangement is quite clearly shown, and the advantage of swiveling the tool *H* is that it does not become necessary to regrind the tool to machine teeth of opposite helical angles (except to maintain a good cutting edge) but only to change the angular position of the tool. At the time that this work was photographed, no cuts had been taken except the preliminary lining up cuts, which show faintly in the illustration at the tops of the teeth.

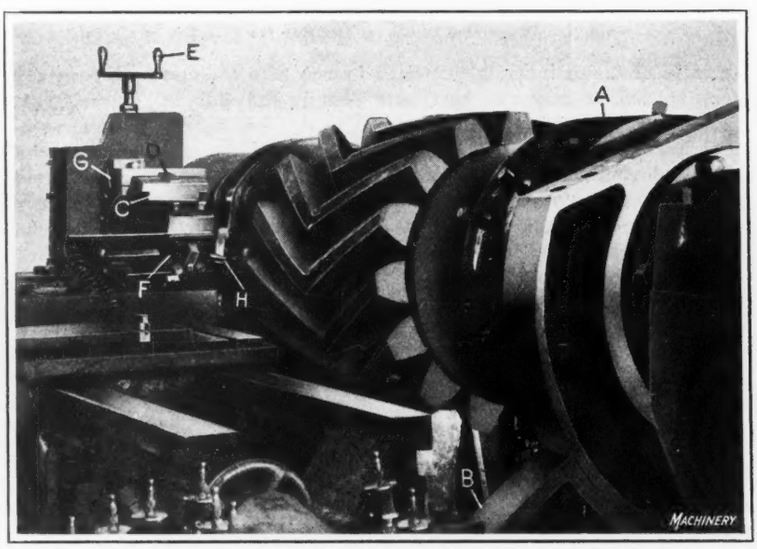


Fig. 5. Cast Pinions of Large Pitch planed on a Machine of Similar Design to that shown in Fig. 2

Lapping and Running-in Machine

By A. B. BASSOFF

Of the various methods employed in fitting automobile engine bearings, it is probably safe to assume that the "running-in" and lapping processes offer the greatest opportunity for improvement along lines tending to increase production and accuracy. Lapping and running-in are two distinct methods, and the incorrect application of the term "lapping" to what is strictly a running-in operation often results in misunderstanding. A lapping operation consists of grinding to size the surface to be finished, by the use of a lap charged with an abrasive; while a running-in operation consists of assembling two parts that are to run together, then applying a mixture of oil and an abrasive, and running the parts thus assembled until they are ground down to size or until the required smoothness of finish is obtained by the action of the abrasive particles in the oil. Both of these methods are employed to obtain the fine bearing surfaces required to eliminate vibration and noise and to insure the proper functioning of engine parts that operate at high speeds.

In running-in bearings, one of the assembled members may be rotated by power while the other is held stationary, but experience has shown that in most cases the best results are obtained by rotating one of the parts by hand. The reason for this is that the workman can change the direction of rotation and also give the work a slight reciprocating movement. The oscillating and reciprocating movements are nearly always employed when performing a lapping operation by hand, and this doubtless accounts for the incorrect application of the term "lapping" to what is actually a running-in operation. When the work is oscillated by hand, the workman can tell by the "feel" if the surfaces are not being finished uniformly, and he can control the oscillating and reciprocating movement to grind down the high portions.

While bearings fitted in this way are in most cases superior to those finished by other means, the method is not all that could be desired. In fact, it is considered a slow expensive process, and it requires the services of skilled workmen. It is also evident that the personal factor makes it impossible to obtain absolutely uniform results.

Function of Lapping Machine

In order to expedite the various lapping and running-in operations, and to provide a means whereby uniform results could be obtained, the writer designed the machine here described. The results obtained with this machine are superior to those obtained by hand lapping, even when the machine is operated by an unskilled workman. The installation of the machine not only made it possible to eliminate one department, but also released twelve skilled workmen from the tedious work of lapping, so that they could be employed on other work. The principal function of the machine is that of imparting to the work an oscillating and a reciprocating motion such as would be employed by a skilled workman.

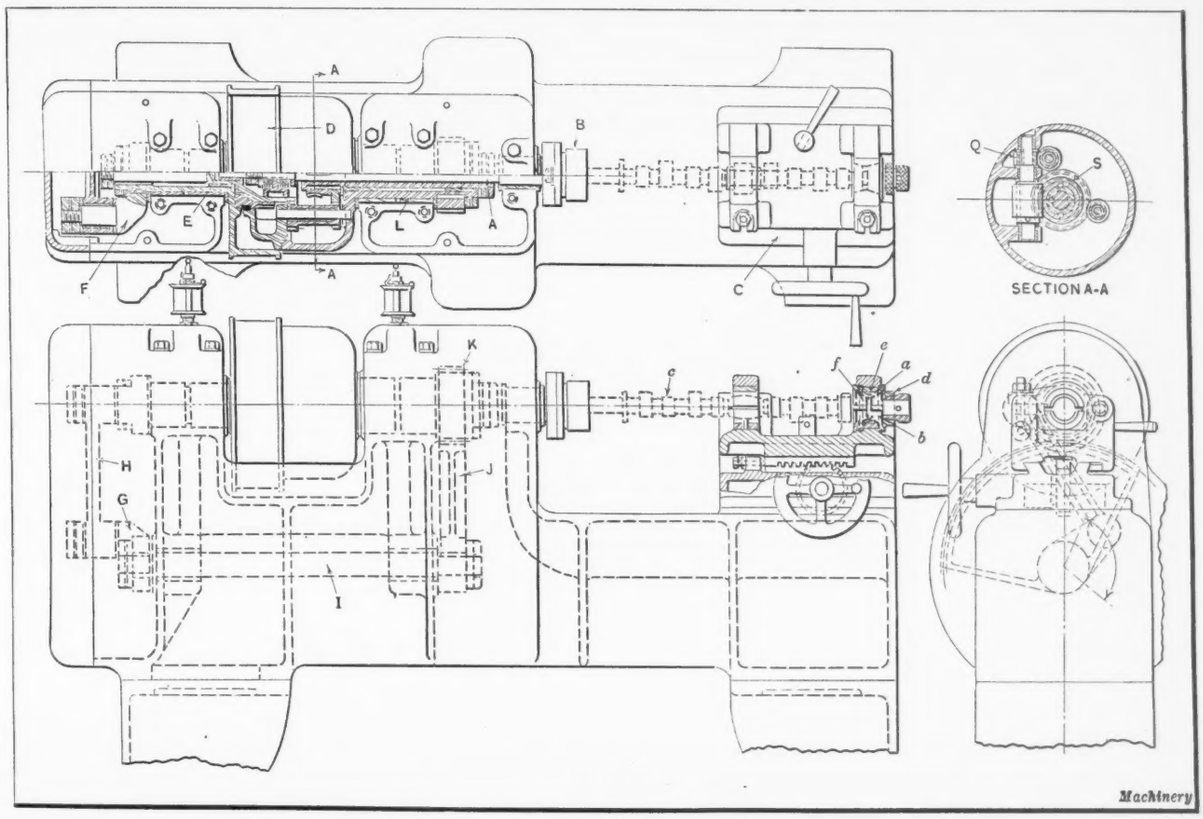


Fig. 1. Lapping Machine which imparts Oscillating and Reciprocating Movements to Work

Referring to Fig. 1, it will be noted that the oscillating movement is imparted to the work through shaft *A*. This shaft is equipped with a chuck *B*, which is designed to permit rapid insertion and removal of the work. One end of the work is supported in tailstock *C*, which is provided with

hinged caps that can be swung back to receive the work, or tightened in place over the work-holding bushings by means of eye-bolts as shown. The diameter of the holes in the cap bearings is sufficiently large to accommodate bushings adapted for supporting the largest work to be lapped.

In some instances, one of the cap bearings may be used to hold a lap or a bearing which is to be run-in with its mating shaft. However, for most lapping operations a special lap-holding stand such as shown in Fig. 3 is employed. It will be noted in Fig. 1 that the tailstock is fitted to the machine by a dovetail slide provided with a rack and pinion adjustment operated by a handwheel. In operating the machine, the workman first throws back the tailstock bearing caps and locates the work in place, after which it is gripped by chuck *B*. The lapping or grinding compound consisting of a mixture of oil and abrasive particles is then applied to the surfaces to be lapped and the machine started. The lapping motion imparted to the work consists of a rotary movement first in one direction and then in the other, with a slight overlapping or advance at each oscillation, and a sliding or reciprocating movement parallel with the axis of the work. The rotary motion with the overlapping stroke brings different points of the work and the lap into contact, thus keeping the work round, while the reciprocating motion prevents it from becoming ringed or grooved.

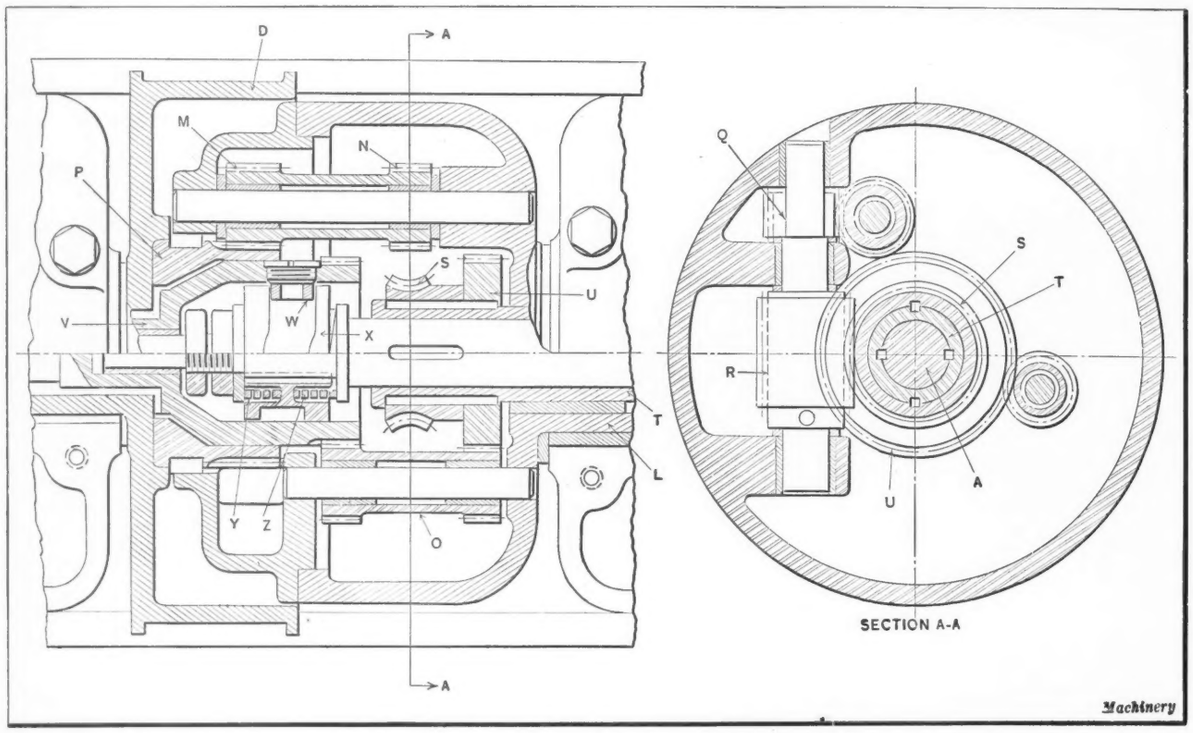


Fig. 2. Oscillating and Reciprocating Mechanism of Lapping Machine

Design of Oscillating Mechanism

The head of the machine has two housings between which is located the flanged pulley *D*, which is driven from a countershaft in the usual manner. This pulley is machined from a steel forging, and has a stem *E* to which is keyed the crank-arm *F*. The entire unit revolves between the two housings of the machine head, all end thrust being taken care of by the thrust collars shown. Crank-arm *F* is connected with crank-arm *G* by a connecting-rod *H*. Crank-arm *G* is keyed to shaft *I* as shown. At the other end of shaft *I* is keyed a sector gear *J* which meshes with gear *K* on the oscillating sleeve *L*.

Oscillating sleeve *L*, which is machined from a steel casting, carries the large end gears *M* and *N* (Fig. 2) which are cut from one piece, as well as the other cluster gear *O*. Gear *M* meshes with gear *P*, which is doweled and screwed to pulley *D*. The spiral gear *N* drives spiral gear *Q*, which is shown in the section *A-A* keyed to the shaft on which worm *R* is held. Worm *R*, in turn, drives worm-wheel *S* to which are keyed sleeve *T* and gear *U*. Cluster gear *O* receives its motion from gear *U*, which is keyed to sleeve *T*. Cluster gear *O*, in turn, drives sleeve *V* which carries the roller *W* located in the groove in cam *X*.

The upper crank *F*, Fig. 1, has a smaller radius of throw than the lower crank *G*, the result being that when the pulley makes a full revolution the lower crank oscillates but does not revolve. The ratio of the gears is such that for each revolution of the pulley the oscillating sleeve makes one revolution in each direction. The worm-gearing, consisting of worm *R* and worm-wheel *S*, Fig. 2, is self-locking, and therefore carries the work-driving spindle *A* (which is keyed to sleeve *T*) around an equal number of revolutions plus the amount that the worm-wheel sleeve is advanced by the epicyclic gear train. This advance constitutes the overlap which has been found necessary, and equals one-quarter revolution for each revolution of the pulley, so that when the pulley makes four revolutions, the work oscillates an amount equivalent to five revolutions in each direction.

Design of Reciprocating Mechanism

The sliding movement is obtained through the drum cam *X* in the following manner: It will be seen that sleeve *V*, which carries roller *W*, cannot slide endwise, whereas the drum cam *X* is keyed to the work-spindle in such a way that it is free to slide on the latter member. As the drum cam revolves the springs *Y* and *Z* are alternately compressed and released, thus producing pressure on the spindle *A*, which acts first in one direction and then in the other. The spindle is also free to slide in sleeve *T*; consequently, as soon as the pressure becomes greater in one direction than in the other, the spindle will slide in its supporting bearing in the direction in which the greatest pressure is exerted. It was found that more satisfactory results were obtained when the sliding movement was transmitted through cushioning springs instead of by positive means. This construction also permitted an even pressure to be exerted on the lapping compound in the case of the running-in operation on the conical bearings of the work.

The gear ratio is such that the drum cam *X* makes a complete revolution once in every twenty revolutions of the pulley as this ratio has been found to give the best results. It should be mentioned that the bearings on the main shaft and the oscillating shaft are not split. This construction was decided upon, as it permits the removal of the entire operating mechanism from the machine as a unit. It will also be seen that there are only two oil reservoirs on the machine, lubrication being effected by a system of leads and ducts, which prevents the possible burning out of bearings and damage to other parts of the mechanism.

Method of Holding Work

Since the work must float back and forth with the spindle, it is necessary that it be rigidly attached to the spindle. It is also necessary that the chuck or whatever means is employed to hold the work to the spindle should be quick-acting. Chucks of different kinds are employed to hold various types of work, the one shown in Fig. 1 being typical of those commonly employed. Referring to Fig. 4, which shows the construction of this chuck, it will be seen that the chuck is composed of a body which is held on the spindle and driven by a tongue. In this body are located three fingers *A*, which swing on pins *B*. These fingers are forced outward by springs *C*. The outer ends of the fingers bear against a sleeve *D*, which slides on the outside surface of body *E*. Sleeve *D* is normally forced outward in the position shown, by spring *F*. The sleeve is prevented from dropping off the body by set-screw *G*, which fits into a slot in part *E*. In loading the work, the operator simply slides sleeve *D* back, thus allowing the fingers to open outward against the recess or counterbored section of the sleeve. This permits the work to be readily inserted or removed. Releasing the sleeve closes the fingers and holds the work securely to the end of the spindle. Two large pins, one of which is shown at *H*, extend into holes in the end of flange *I* on the work, thus providing a positive drive. It will be noted that there are few working parts in the chuck, and that although it is easy to dismount it for the replacement of worn parts, the wearing surfaces are so well protected from dust that they should have a long life.

Types of Work Lapped

While this machine has not been employed or fitted up for internal lapping, it will be evident that it is adapted for this kind of work as well as for external work, provided suitable equipment is employed. Although the machine is employed for finishing a great variety of bearings, some of the more common operations for which it is used are lapping or running-in camshaft bearings, lapping timing gear shafts, crankshafts, and piston wrist-pins. These illustrations are representative of the automobile industry, but the nature of the machine is such that it is suitable for lapping almost any kind of round work. The running-in operation on the cone bearing of the camshaft, which is shown in heavy dot-and-dash lines in Fig. 1, is performed in order to obtain the required fit between the conical surfaces of bearing *a*, held in the tailstock of the machine, and the conical bearing collar *b*, held on the camshaft *c* by means of nut *d*. A mixture of oil and emery is applied to the bearing surfaces as a grinding compound. It should be understood that cone *b* is a separate piece, and is keyed to the camshaft when the latter is assembled in the motor. When in the lapping machine, a spacing collar *e* is placed between cone *b* and the fixed cone *f*, so that there is a small space between cone *b* and bearing *a*; then when the tailstock is properly adjusted the reciprocating motion imparted by cam *X*, Fig. 2, will bring the surfaces to be ground into contact, rotate the shaft first in one direction and then in the other, and release the parts from contact at regular intervals. For grinding the cone bearing *f*, it is only necessary to advance the tailstock toward the head of the machine the proper amount by means of the handwheel, and then repeat the running-in operation previously described.

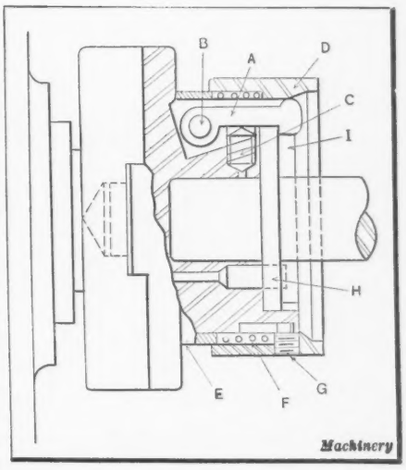


Fig. 4. Special Chuck for holding Flanged Shaft

In lapping straight bearings, a stand such as shown in Fig. 3 is employed to hold cast-iron laps *A* and *B*. The stand *C* consists of a tool-steel forging having a T-slot in which blocks *D* and *E* may be adjusted by means of screw *F*, which is provided with right- and left-hand threads. A knurled nut *G* having graduations reading to 0.0002 inch is attached to the end of screw *F*. The jaws *D* and *E* are lapped all over, as is also the slot in which they are fitted. Taper blocks *H* and *J* are employed to take up wear and to make any transverse adjustment of the screw that may be necessary to center or locate the laps properly.

* * *

In a recent address by Mr. Hoover relating to world trade, it was pointed out that the reparation payments exacted from Germany must have a profound effect upon the economy of the whole world. Germany is to pay to the Allies $500,000,000, plus 26 per cent export duty, or, say, a minimum of about $750,000,000 a year. As she is left without much gold, foreign property, or foreign business earnings of consequence, these payments must be made mostly by the sale of manufactured goods outside her borders. But beyond the reparation payments, she must also sell sufficient goods abroad to buy her imports of food and raw materials. Any calculation based on the pre-war trade of Germany implies an enormous increase of her pre-war exports. In view of the export duty and other payments, she must produce these goods for about one-half our production cost in order to take our markets. Such an increase in exports must be in manufactured goods, and until the world consumption grows, these must be marketed in displacement of the goods of other industrial nations. We shall certainly feel the effects of this flow of goods that must be produced if she is to make reparation payments. On the other hand, Germany must take more raw materials from us for this purpose. However, the crowding in the market of German exports will affect her immediate neighbors more than us, for 80 per cent of her market must lie in Europe itself.

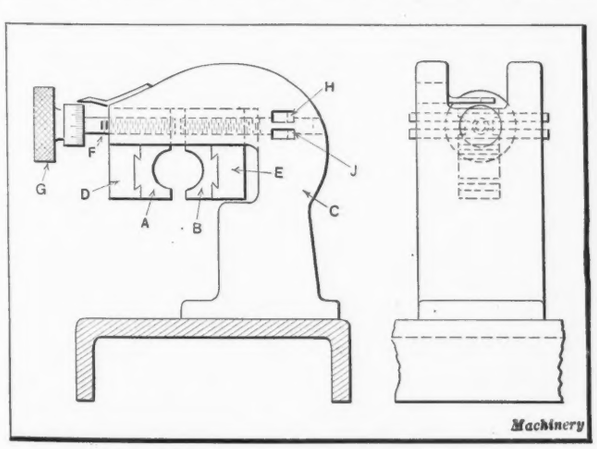
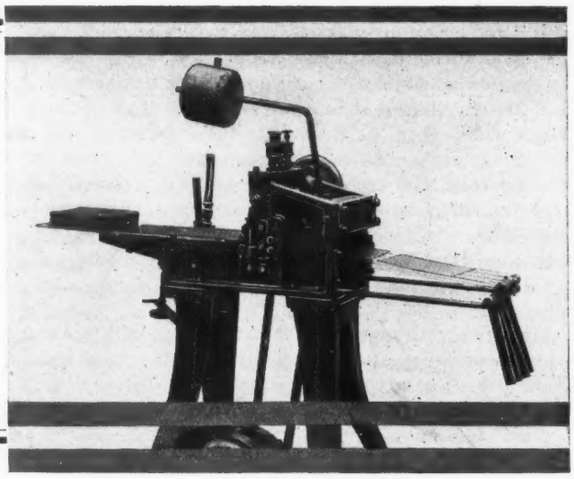


Fig. 3. Stand for holding Laps

Punching Storage-Battery Insulating Sheets

By CHARLES O. HERB



THE necessity of developing a single-purpose machine for performing some operation for which no machine on the market is adapted frequently confronts a manufacturer. The present article deals with a machine designed, patented, and built by the Commercial Truck Co., Philadelphia, Pa., for punching rows of narrow slits in the hard rubber sheets used for insulating purposes in the electric storage batteries employed in driving the motor truck manufactured by this concern. This machine has proved satisfactory in every respect, and is here described because it is believed that some of the mechanical principles incorporated in its design may be of interest and value.

Use of the Hard Rubber Sheets

In the storage batteries mentioned, wooden plates are placed between the negative and the positive metallic plates, and sheets of hard rubber are placed between each wooden plate and a negative or a positive plate, as the case may be. An idea of the manner in which the rubber sheets are punched may be obtained by reference to Fig. 2, which shows the full width of a sheet but only a portion of the length. The sheets are actually about 8½ inches long, 5¾ inches wide, and range from 0.015 to 0.025 inch in thickness. It will be observed that there are 22 rows of slits, the slits being 0.009 inch wide, 3/16 inch long and spaced thirty-two to an inch. There is approximately 0.022 inch of rubber between each slit in a row, and the unpunched rubber remaining between each row is about 1/16 inch wide.

The function of the slits in the rubber sheet is to permit the electrolyte to filter through to the various plates, but it is essential that the holes be of such a size and shape that the chemical salts from which the electrolytic solution is obtained are not carried through the rubber sheets with the solution. Prior to the use of slits of the type shown, circular holes were used in the rubber sheets, but these were unsatisfactory because, in order to obtain the same amount of filtering area, it was necessary for each hole to have approximately the same area as one of the present slits, and circular holes of such a size permitted the electrolytic salts to seep through. In designing the machine for punching the slits, it was evident that if the operation was to be performed on an economical basis, it would be necessary for the tools to be operated at a high speed. A view of the machine as finally constructed is shown in Fig. 1.

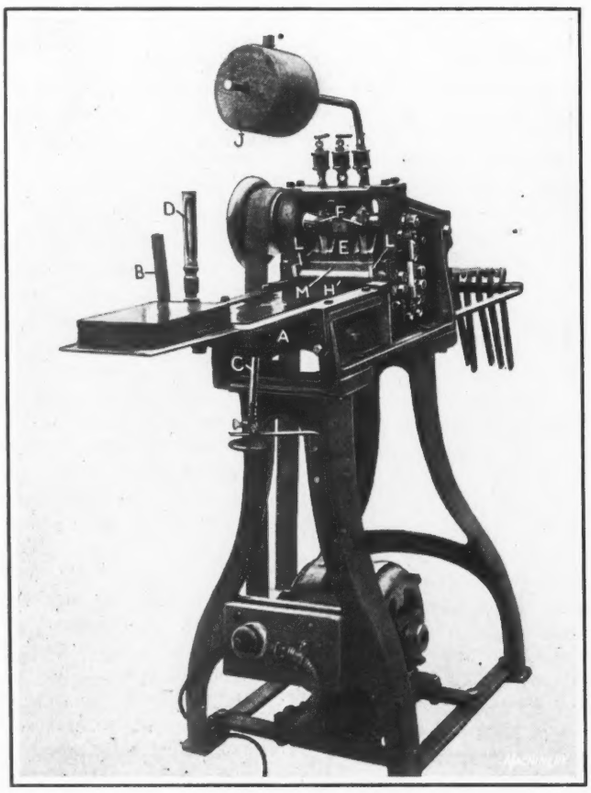


Fig. 1. Punching Machine developed for cutting Rows of Slits in Storage Battery Insulating Sheets

Construction of Punching Machine

The machine has a vertical ram, which reciprocates at a rapid rate. Attached to the lower end of the ram is a block containing twenty-two blades that pass through a stripper plate and into corresponding slits in a die beneath, during which movement a series of slits is produced in a rubber sheet. One of the problems encountered with the machine was that the sheets would crack and break when the punch blades came in contact with them, due to the brittleness of hard rubber. This difficulty was overcome by including a water chamber in the construction of the machine, the water in which is heated to a temperature of about 150 degrees F. The sheets are passed over the upper surface of this chamber prior to being fed through the machine, with the result that the rubber becomes sufficiently pliable to permit the successful performance of the punching operation. It will be evident that it is necessary to advance the rubber sheets a certain amount during each ram stroke and to keep them stationary while being punched. This intermittent movement is obtained by the provision of a mechanism to be described later.

The water chamber for preheating the rubber sheets is indicated at *A*, Fig. 1. It is filled by means of pipe *B* which is closed with a cap after sufficient water has flowed into the chamber. Provision is made for draining the chamber when the occasion demands. The chamber

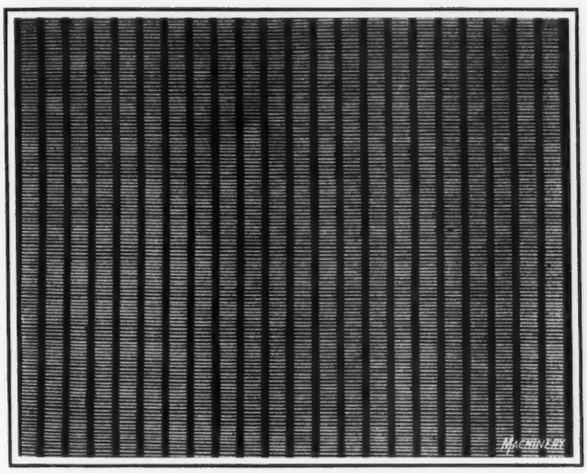


Fig. 2. Hard Rubber Sheet slit by Punching Machine shown in Fig. 1

is heated by means of gas-burner *C* which is connected to a gas supply line. The temperature of the water in the chamber can be ascertained at any time by reference to thermometer *D*. The illustration shows a pile of sheets lying on the sheet-metal bracket extending in front of the water chamber and two sheets lying on the water chamber. Ram *E* to which the punch-holder is attached is reciprocated up and down by means of two cranks *F* mounted on a horizontal crankshaft having a throw of 0.10 inch. This crankshaft is made of chrome-nickel steel, heat-treated, and it carries near the left-hand end a pulley connected by a belt to the pulley of the driving motor bolted on the bar supports at the bottom of the machine.

This motor is of ½ horsepower, and is connected to a lamp socket; it operates at the rate of 1750 revolutions per minute. As the ratio between the motor and machine pulleys is 6 to 7, the crankshaft rotates at the rate of 1500 revolutions per minute, the ram reciprocating the same number of times. A flywheel mounted on the left-hand end of the crankshaft beyond the pulley insures uniform operation of the ram. The crankshaft is mounted in a large Hess-Bright ball bearing where it extends through the left-hand frame, while other bearings support the crankshaft at the right-hand end and at the center.

Ram Support

A unique feature of the machine is that the ram does not operate in slides, as in common types of punch presses, but instead is supported by the outer ends of four parallel springs. Three of these springs may be seen in Fig. 3 at *G*. The photograph reproduced in this illustration was taken with one side of the machine frame removed, to permit the method of attaching the ram to be easily seen. The back ends of the springs are secured to the tying member of the machine frame at the rear. By this arrangement a rigid construction is obtained. It is evident that with this design the punch blades actually traverse in an arc rather than in a directly perpendicular path. However, the radius of the arc in which the blades operate is so great, and the distance that they enter the die openings so small, that the horizontal movement of the blades in the die is negligible and no difficulty arises from this source.

Intermittent Feed Mechanism

Attention has been called to the fact that it is necessary to move the rubber sheets a certain amount during each stroke and to hold the sheets stationary while being punched, so that the slits will be properly spaced. This movement of the sheets is obtained by four rollers, two of which are placed in front of the die and two at the rear, the four rollers being rotated intermittently. Three of these rollers are shown in Fig. 3 at *H*. The intermittent movements are obtained through the mechanism on the right-hand side of the machine which may be seen in Fig. 1. On the right-hand end of the crankshaft is a collar having a projecting pin that successively engages each of the six teeth of a Geneva gear mounted on a parallel shaft directly below the crankshaft. The duration of each engagement is sufficient to cause the Geneva gear to be rotated through an arc of 30 degrees, and during the remainder of a revolution of the crankshaft the Geneva gear remains stationary.

Helical teeth cut on the outer end of the shaft on which the Geneva gear is mounted mesh with a helical gear on the upper end of a vertical shaft. This vertical shaft also carries a helical gear at the lower end, which meshes with teeth machined on a horizontal shaft. On each end of the horizontal shaft, in turn, is mounted a helical gear, and these gears drive a gear on each of the lower rollers *H*, Fig. 3. The upper roller in each case is driven by another gear meshing with the one on the corresponding lower roller. Thus, ten helical gears, a Geneva gear and a special collar are contained in the intermittent gearing. The reduction obtained by this gearing is such as to give the rollers and sheets the required movement. One advantage secured through the employment of helical gears in this mechanism is that, although the fine rubber punchings may in some way be carried to the gearing, the sliding action of the teeth of the various gears in those of their mates is such as to cause the punchings to be easily worked out, and so they do not cause clogging. A cover is provided for this gearing, but this was removed at the time the photograph was taken.

Maintaining Friction between Feeding Rollers

A certain amount of friction must be maintained between the two rollers in each set to insure that the rubber sheets will be moved with the rollers. This friction is secured by means of counterweight *J*, Fig. 1, which is attached to a bent rod inserted in a suitable holder on shaft *K*, Fig. 3. Long projecting fingers also mounted on this shaft extend forward and rest upon wooden strips *L*, Fig. 1, which are hollowed out to suit the upper rollers on which they lie. By swiveling the counterweight rod from the position shown, the weight is brought to the rear of the machine and the fingers previously mentioned are raised. This removes all pressure from strips *L* so that they and the upper rollers may be quickly taken out to permit an inspection of the punch and die.

As the finished rubber sheets pass through the rear rollers, they are conveyed on ribbon belts, as shown in the heading illustration, to the back of the machine. The conveying

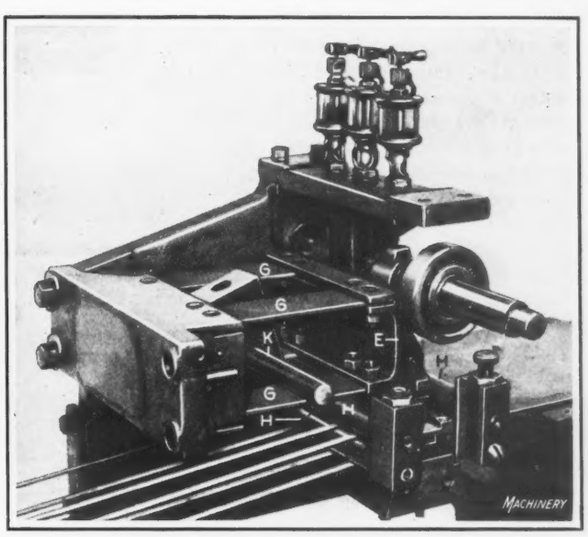


Fig. 3. Method of supporting the Ram on the Free Ends of Four Flat Springs

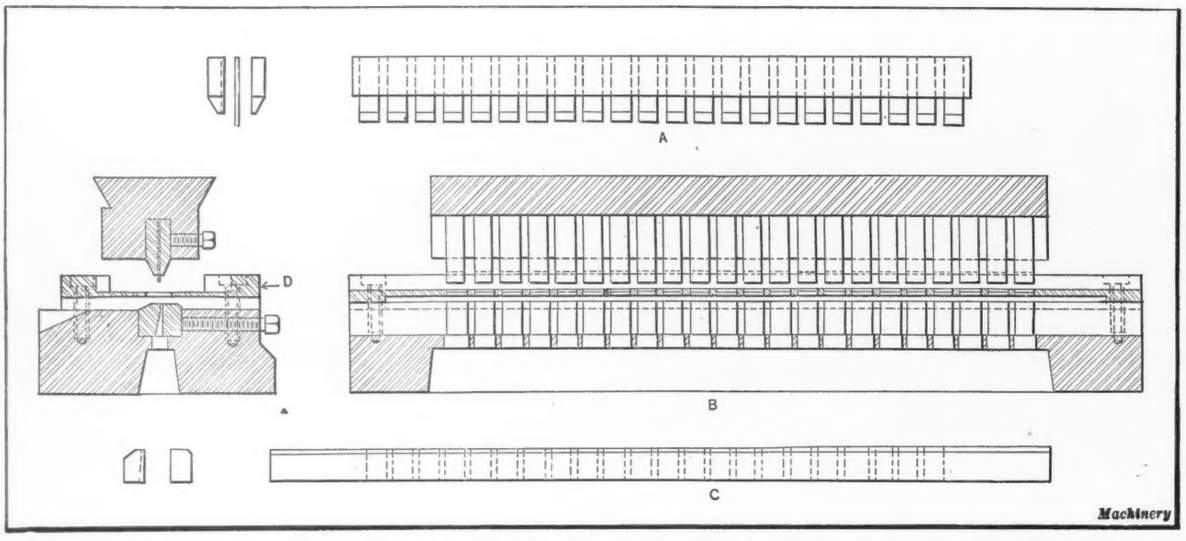


Fig. 4. (A) Punching Blades and their Strips; (B) Arrangement of Punch and Die Parts on Machine; (C) Die Strips

ribbons are driven by means of the lower of the rear set of rollers, which are grooved for that purpose. At the end of the machine, the ribbons pass over small pulleys mounted on weighted brackets which hold the ribbons taut. It will be noticed that lubricant is furnished to the various bearings by means of sight-feed oilers.

Punch, Stripper Plate, and Die

The construction of the punch, stripper plate, and die used on the machine is illustrated in Figs. 4 and 5. In Fig. 4 at *B* these parts are shown in the manner in which they are assembled on the machine. The punching blades are held in place by two steel strips that have fingers extending almost to the lower end of the blades as shown at *A*. The surface of one of the strips in contact with the blades is flush the entire length, while the contact side of the other strip has recesses milled to suit the width and thickness of each blade. The strips and blades are held together in the punch-holder by twenty-two set-screws as shown at *B*, and at *A*, Fig. 5. By clamping the blades individually in this way, each one may be adjusted independently of the others.

The punch-holder is secured to the ram of the machine by means of the dovetail tongue at the top, the rear side of the dovetail, that is, the side on which the set-screw heads are placed, being supported by a corresponding slot in the ram. The front dovetail surface is supported by the gib *M*, Fig. 1, one side of which is machined to suit. By this arrangement the punch-holder is securely held to the ram in a way that permits its ready removal. The stripper plate *D*, Fig. 4, is attached to the upper surface of the die-block and is so machined that not only the punch blades extend through its openings, but also the supporting fingers of the strips which hold the blades.

The openings of the stripper plate are hollowed out on the under side as shown at *B*, Fig. 5, so that the rubber sheets will not be stripped along the sides of the slits, but rather at the ends. By employing this principle, the narrow sections of rubber left between the slits in a row do not become torn, as would otherwise be probable. The die consists simply of two long strips as shown at *C*, Fig. 4, which are held in the die-block by means of set-screws as illustrated at *B*, and at *C*, Fig. 5. One of the strips is flat on the side which comes in contact with the punch blades, while the corresponding surface of the other is milled out to suit the blades. The punchings are forced through the die and fall into a receptacle beneath.

The punch-holder and die strips are made of a water-hardened non-shrinkable tool steel. An average of 2500 rubber sheets is punched before it becomes necessary to regrind the punching blades, which means that about 700,000 holes are punched by each blade. The long life of the blades is attributed to the rigid manner in which the machine ram is operated, and to the construction of the punch, die, and stripper plate.

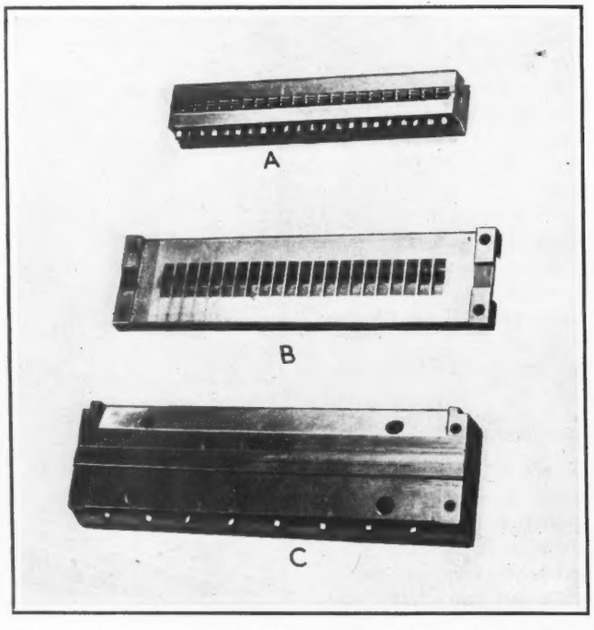


Fig. 5. (A) Assembled Punch-holder; (B) Under Side of Stripper Plate; (C) Die Strips assembled in Die-block

* * *

MEETING OF AMERICAN ENGINEERING COUNCIL

The next meeting of the Executive Board of the Engineering Council of the Federated American Engineering Societies will be held at the Cosmos Club in Washington, D. C., September 30. The most important business coming before this meeting will be the election of a president to succeed Herbert Hoover, who resigned when he became Secretary of Commerce. Special attention will also be given to the extension of the employment service, and the question of licensing and registering engineers. Plans are also being made for a general engineering meeting, to be held in conjunction with the annual meeting of the American Engineering Council some time in the latter part of January. At this meeting such topics will be taken up as the elimination of waste, licensing of engineers, a governmental department of public works, and other subjects of importance.

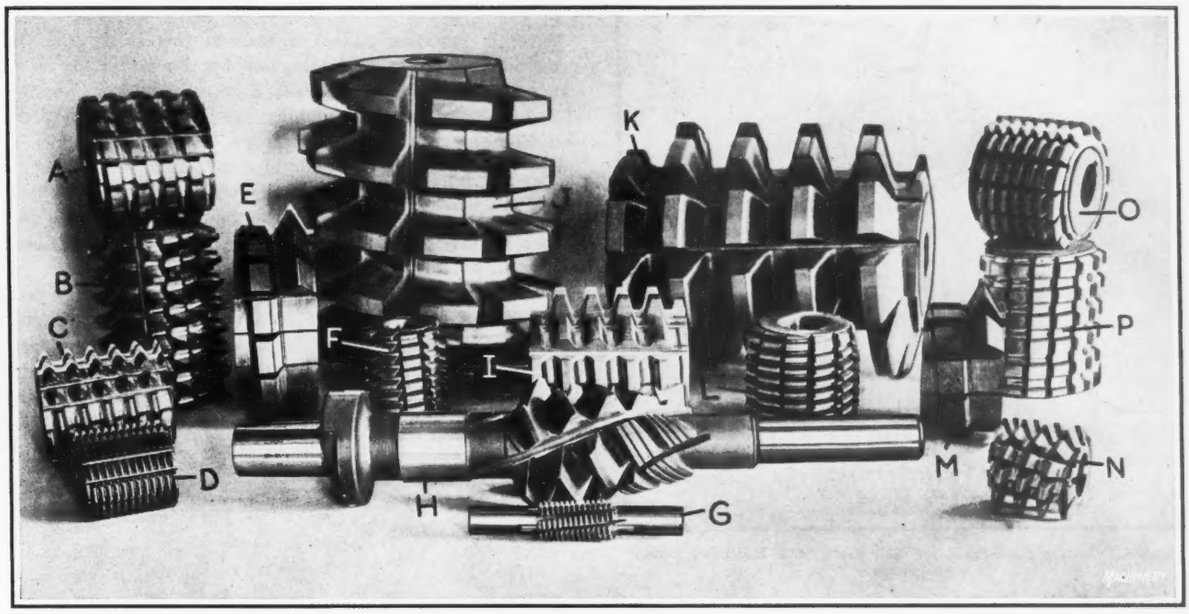


Fig. 1. Collection of Different Types of Hobs

Inspection of Involute Spur and Helical Gear Hobs

Testing the Accuracy of Hob and Tooth Parts—Hobbing Test—First of Two Articles

By CARL G. OLSON, Chief Engineer, Illinois Tool Works, Chicago, Ill.

EVERY user of hobs is interested in methods which will help him, when a new supply of hobs is received, to determine quickly if these tools are made with the accuracy required for his work. The purpose of this article is to point out and explain practical ways of conducting the inspection, whereby definite conclusions may be quickly reached. Broadly speaking, the inspection of hobs consists of determining whether or not orders have been correctly interpreted, and whether the hobs are made in accordance with the specifications given in these orders. The correctness of the type and size are first checked. Then the tooth parts are carefully gaged and examined before making the final test of cutting sample gears.

Type of Hobs

The term "type of hobs" refers to whether they are made for spur and helical gears or for other hobbed work, whether they are single or multiple threaded, straight or helically

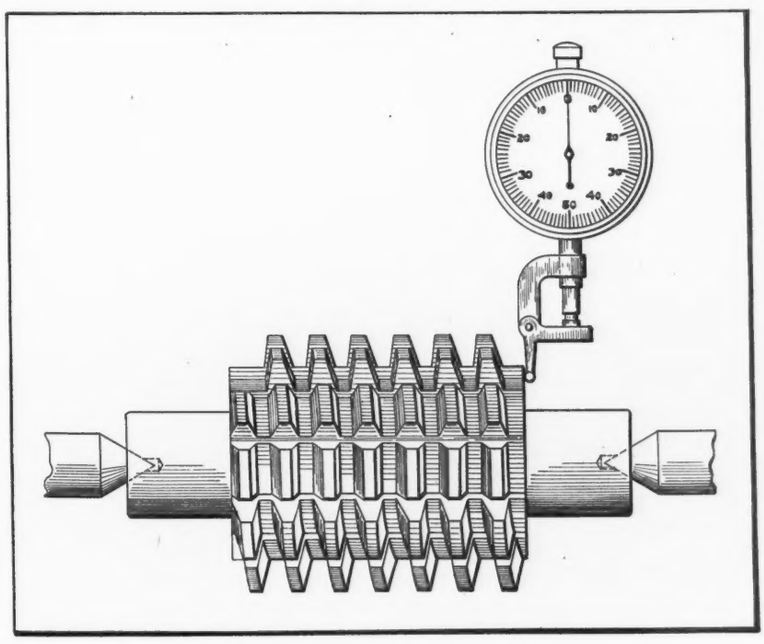


Fig. 2. Testing Accuracy of Hob at End of Arbor

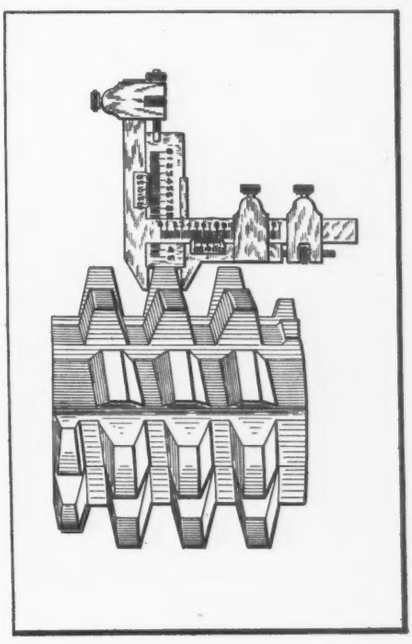


Fig. 3. Calipering Dimensions of Hob Teeth

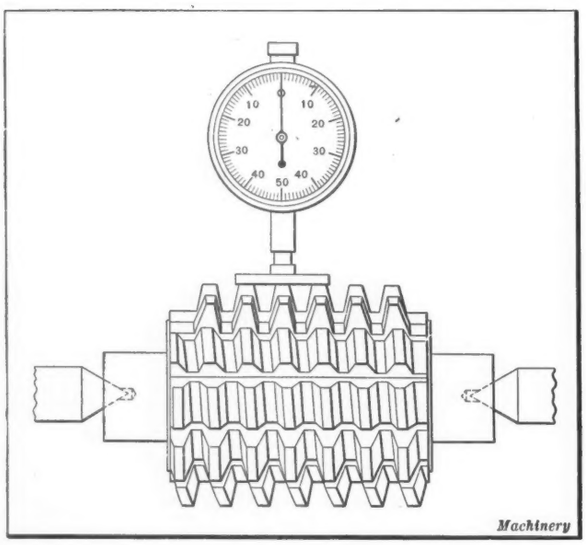


Fig. 4. Testing Eccentricity of Hob Teeth with Indicator, after sharpening

fluted, whether they have an arbor hole or shank, and whether they are intended for the roughing or finishing of gears. Several types of gear hobs are shown in Fig. 1, the letters referring to various types as follows: *A*, spline shaft hob; *B*, right-hand spur gear hob with hooked teeth; *C*, silent gear sprocket hob; *D*, standard straight-gash spur gear hob; *E*, Gould & Eberhardt type stepped-tooth worm hob; *F*, spur gear hob with helical flutes; *G*, shank type of hob; *H*, worm-gear hob used on machine equipped with tangential feed mechanism; *I*, spur gear hob; *J*, left-hand hob for helical gears; *K*, right-hand hob for helical gears; *L*, spur and helical gear hob with tapered end; *M*, Gould & Eberhardt type stepped-tooth worm hob; *N*, double-thread worm-gear hob; *O*, special spur gear hob; and *P*, spline hob.

Size of Hobs

The diameter and length of hobs of standard pitches, used on the various makes of hobbing machines, are given in the hob manufacturers' catalogues. These measurements do not usually require precision, but the cutters should be true cylinders at the points of the teeth, and the ends should be perfectly parallel and at right angles to the axis of the hobs. The accuracy of these conditions may be inspected by the methods shown in Figs. 2 and 4. The face and ends of the hob are checked with an indicator, while the hob is held on an accurate arbor, and is turned on true centers.

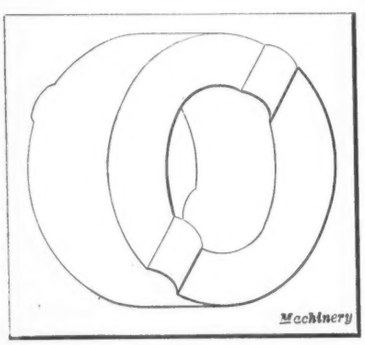


Fig. 5. Form of Equalizing Collar

Tooth Parts

The dimensions of the teeth in hobs are the same as the corresponding dimensions in racks and gears. The thickness of the teeth at the pitch line is equal to one-half the circular pitch; and the width of the space between the teeth, measured on the pitch line, is also equal to one-half the circular pitch. Therefore, the spacing of the teeth, measured between corresponding points, is equal to the circular pitch. The gear tooth caliper, shown in Fig. 3, is a convenient tool for checking the dimensions of hob teeth. In diagrams *A* and *B*, Fig. 6, is given the interpretation of the notation of the tooth parts, and also dimensions for 1 diametral pitch. Complete tables of tooth parts may be found in MACHINERY'S HANDBOOK.

Hobbing Test Gears—The Final Proof

After a hob has passed a general inspection, the final proof of its quality is determined by the perfection of the gears it will cut. To produce a good gear with any hob, it is necessary that the hobbing machine be kept in proper condition and that the setting up be carefully done. In preparing a machine for making a test, it is very important for the spindle bearings and the slides of the machine to be carefully adjusted, and for the gears governing the ratio of the spindles to mesh properly. The gears must not be too tight, as this will cause vibration in the machine. All minor adjustments and precautions necessary to care for a machine properly should be observed. The hob and gears are mounted on their respective arbors in the machine, after these parts have been carefully tested to ascertain that they are true. The shoulders on the arbors, as well as the ends of the collars and the nuts, must be perfectly true. A frequent test of these points of precision should be made, as illustrated in Figs. 8, 10, and 11.

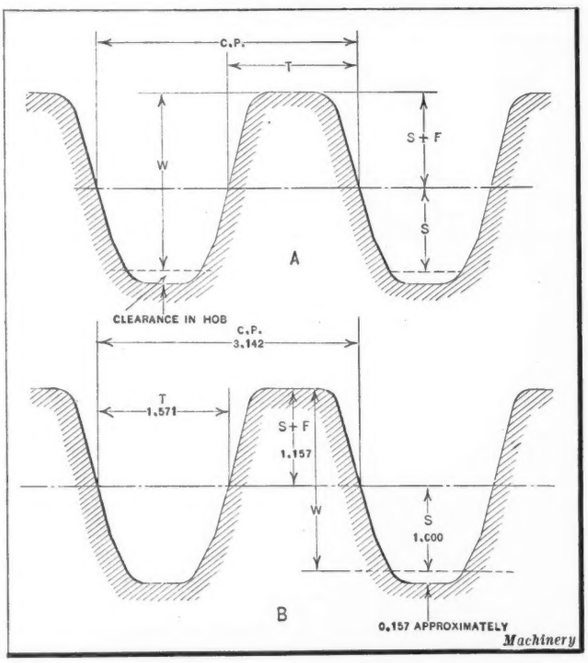


Fig. 6. Notation of Tooth Parts and Dimensions for 1 Diametral Pitch

The collars next to the hob on the arbor should be ground perfectly true inside and outside, and should fit the arbor exactly. When this is carefully done, the indicator may be used directly on these collars, on each side of the hob, as shown in Fig. 12, to determine whether or not the arbor has sprung in tightening the nut. The gear blanks, Fig. 9, should also be tested with an indicator after tightening the nut of the work-arbor. If it should be found, after these precautions have been taken, that the parts do not run perfectly true, the cause may be looked for in the accumulation of minute errors in the different parts; and when this occurs, the trouble is difficult to detect.

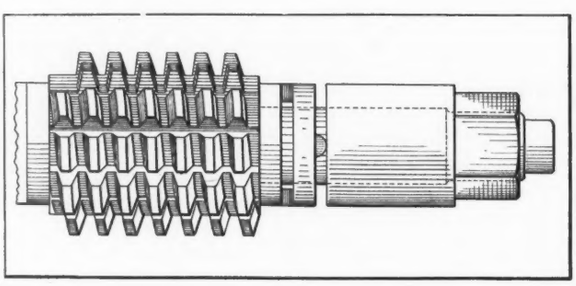


Fig. 7. Application of Equalizing Collar of the Type shown in Fig. 5

Equalizing collars are sometimes used to overcome these difficulties, one of which is illustrated in Fig. 5 and shown assembled on the arbor in Fig. 7. These equalizing collars are made with ridges on each side, the ridges on one side being located at right angles to those on the other side of the collar, as shown in the illustration.

In cutting test gears, it is best to take a roughing cut and a finishing cut, with only a slight amount of stock left for finishing. The proper depth is obtained by measuring the root diameter, after taking the roughing cut, subtracting from this the finished root diameter, and then feeding the hob in an amount equal to one-half the difference so obtained. This measuring is done with a vernier caliper or a micrometer. If the gears have an odd number of teeth the measurements may be taken from the root of one side to the outside of the opposite side; and by making the necessary allowance for the depth of the cut, the diameter may be found. The gears are ordinarily inspected by the use of master gears, but when no master gears are kept for this purpose, two gears must be cut for making the tests. The following article in this series, which will appear in October MACHINERY, will describe the methods and equipment used in making the involute test, the jump test, and the roll test on involute gears.

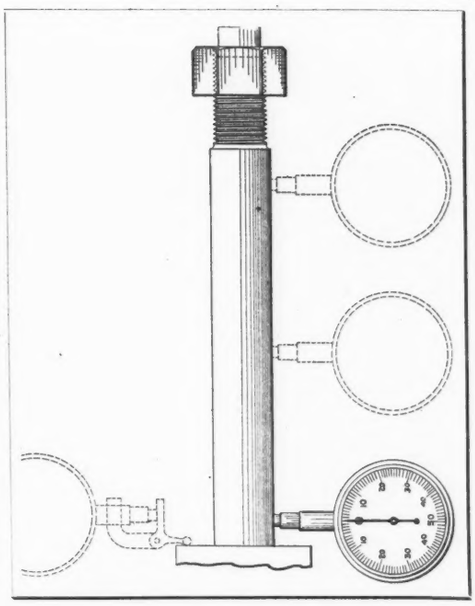


Fig. 8. Testing Accuracy of Work-arbor

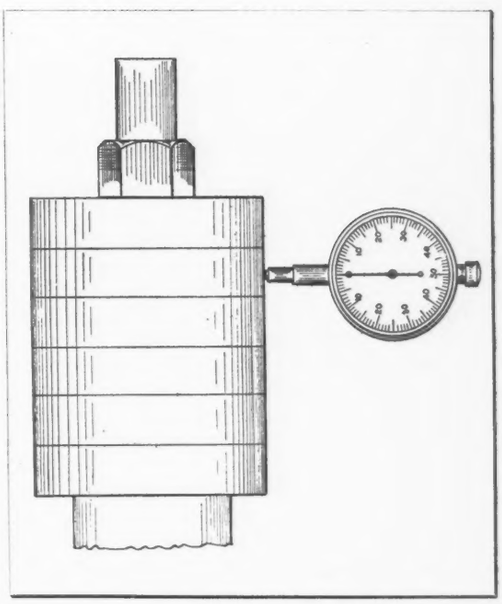


Fig. 9. Testing Accuracy of Gear Blanks after tightening Nut

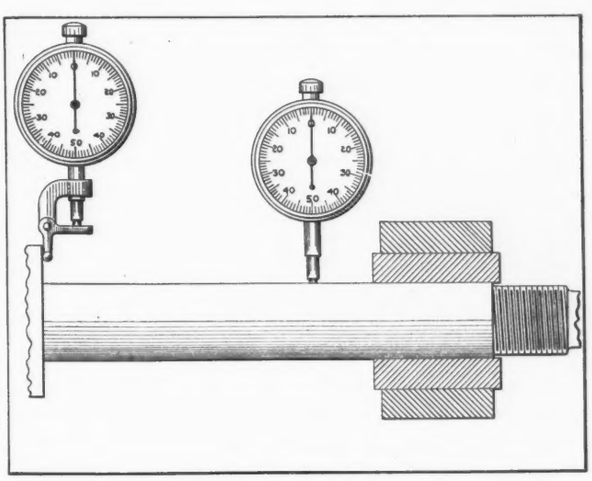


Fig. 10. Testing Accuracy of the Hob Arbor

ENGINEERING EDUCATION IN UNITED STATES

Statistics compiled from the reports of eighty-one engineering colleges located in thirty-six states show that at present there are over 12,000 students enlisted in mechanical and an equal number in engineering courses, 8600 in civil engineering, 6500 in chemical engineering, 2400 in mining engineering, and 6500 in miscellaneous special engineering fields, making a total of over 48,000 students registered in engineering schools. Fourteen of these colleges have more than 1000 students, the highest figure being that of the Massachusetts Institute of Technology, with 2747 students. The next in order are the University of Michigan with 2212; Purdue University with 1845; Cornell University with 1825; and the University of Illinois with 1818.

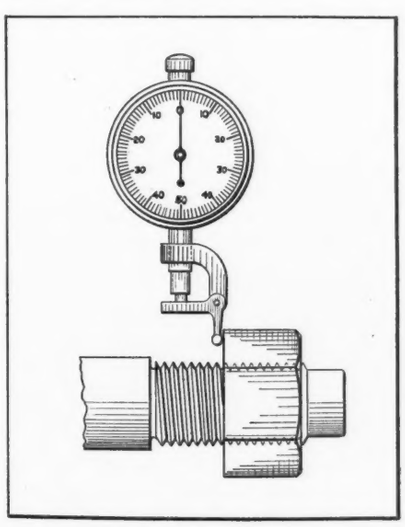


Fig. 11. Testing Accuracy of Arbor Nut

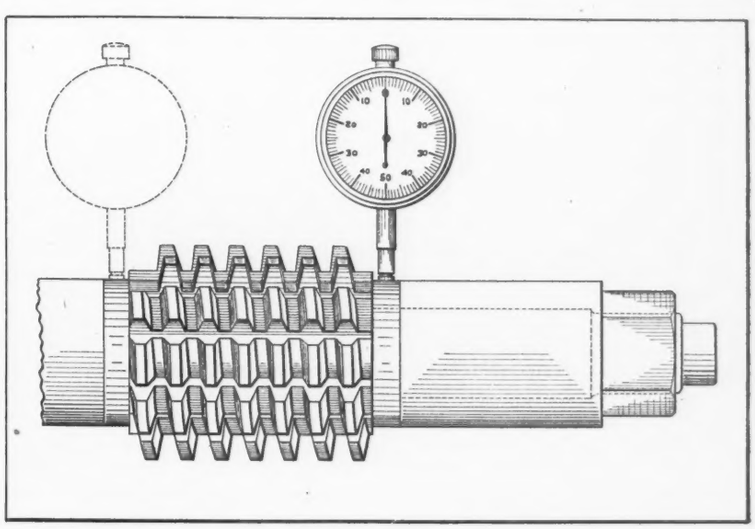


Fig. 12. Testing Accuracy of the Hob Arbor after tightening the Nut

Demonstrating Machine Tools

By HOWARD W. DUNBAR, Sales Manager, Grinding Machine Division, Norton Co., Worcester, Mass.

THE old adage "He who serves best profits most" is probably reflected more in the machine tool industry than is generally admitted. One of the essentials in the sales program of every successful machine tool builder is to render service to his customer, not in the sense of doing the things for him that are a legitimate part of his own, everyday routine work, but by giving the customer help in the truest sense of the word, when help is needed; and this can best be done by aiding the users of machine tools in getting out of them the most there is in them. It is better policy by far to show a customer how he can do more work with the equipment he has than to encourage him or influence him to buy more machines; because sales based on such encouragement or influence do not build up good-will for the concern, and this, after all, is one of the greatest assets that any machine tool manufacturer can have.

There are three distinct points that should be taken into account by a demonstrator in carrying out demonstration work in a customer's shop: (1) He must thoroughly instruct the user of the machine tool in obtaining the best results from the machine by its proper operation and care—this is to render real service. (2) As a result of this service he should try to impress on the customer the value, efficiency, and suitability of the machine tools that he is demonstrating, and to firmly impress the name of his concern upon those with whom he comes in contact, as one that stands for quality and integrity in machine tool building. (3) He should collect data and facts relating to the service given by the machine and its productive capacity. Such data later will prove of great value in increasing the service that the machine tool builder can render to this and other customers.

Service visits should not be limited to responses for calls for help. When a machine tool manufacturer has once established friendly relations with a customer by the demonstration of a machine, he can maintain cordial relations by calling for the purpose of inquiring concerning the operation of the equipment. This kind of attention has a double value. The machine tool builder learns of proposed plans for expansion that may mean additional business, and the customer learns that the service the machine tool builder renders is not of a temporary nature, but really permanent.

Instructing the Users of Machine Tools

With the sale of most machine tools in these days there is practically a tacit understanding that a demonstrator will be sent to the customer's plant to see that the machine is properly installed, instruction given to operators in its proper functioning, and a demonstration made to prove the ability of the machine to produce according to stipulated representations or guarantees. The majority of machine tools today are sold on the basis of their ability to produce certain quantities of work in a given time and of predetermined quality. On all new types of machines, wherever a definite guarantee is made, it is important to assist the customer in this way, both in order that he may obtain from the machine the very best results, and in order to safeguard the interests of the machine tool manufacturer.

Some customers show a tendency to take advantage of this willingness of the machine tool builder to render service. The fact that this service is available sometimes makes it too easy for the customer to call for assistance when it is really not required. When, for example, a concern is a large user of a certain type of machine tool, it is quite unnecessary for the manufacturer to go to the expense and trouble of sending a demonstrator with any additional machines that he may be furnishing to his customer, and there is no object in making an offer of a demonstration in such a case.

Sometimes the customer asks and actually requires services beyond those that may legitimately be given to him without cost. In that case an arrangement should be made whereby a demonstrator is sent to perform the specific work outlined, but the demonstrator's time and expenses should be charged for at a nominal rate. For example, suppose a concern should order several sets of spindle boxes for machines that had already been in operation for a number of years, and should request the machine tool builder to send a man a distance of several hundred miles to install and fit the boxes. In cases of this kind service rendered to a customer should be charged for, and the customer should not expect to be given such service for nothing.

Establishing a Reputation

If a machine tool manufacturer is always ready to furnish a customer with the proper kind of service, if he is always ready to lend a helping hand, and if through capable demonstrators he is able to prove the ability of his machines to produce accurately in quantity and continuously, it is inevitable that this kind of service will reflect credit upon his concern and ultimately lead to more business. Every machine tool manufacturer should endeavor to gain a high reputation for the kind of service that he gives. This can only be done by rendering a service that does not savor of patronizing, but the kind that helps a customer out of a tight hole when he needs help the most. Experience has proved that there is no easier way of securing orders than by following this policy. No hard work or extravagant promises are necessary to obtain a new order. It comes naturally and surely, if proper service and demonstration have been given in connection with former sales.

Service visits should not be limited to responses for calls for help. When a machine tool manufacturer has once established friendly relations with a customer by the demonstration of a machine, he can maintain cordial relations by calling for the purpose of inquiring concerning the operation of the equipment. This kind of attention has a double value. The machine tool builder learns of proposed plans for expansion that may mean additional business, and the customer learns that the service the machine tool builder is prepared to render is really permanent.

The Collection of Data and Facts for Future Use

In order to assist in the development of the business, and to enable the highest type of service to be rendered constantly, it is necessary that data be collected and returned to the home office of the machine tool builder, where it should be recorded for future reference. This data should cover results in regard to production; questions relating to the best kind of tools to be used; and anything that may be of value in the future in selecting the proper equipment for a similar job, either in the same plant or elsewhere. By

collecting and recording such data the demonstrator himself acquires a valuable fund of knowledge, which assists him in his work; and the home office becomes a clearing house for information relating to performances that will be of the greatest value in developing new business.

It is evident that a demonstrator will also make it a point to study the performance of competitive machines, noting what they are doing, and particularly observing wherein they may excel his own, so that by making proper suggestions, steps may be taken to overcome any failings or shortcomings that may exist in the equipment being built by his own firm.

In order to facilitate the work of recording such data as may be collected in connection with the demonstration of machines in a customer's plant, forms should be provided so that the demonstrator can merely fill in information relating to speeds and feeds, depth of cut, production per hour, etc. These blanks should be filled in as completely as possible; but if certain data are not known, it could simply be noted on the blank by filling in the word "unknown," or, if the exact data were not available, but the demonstrator should judge the condition to be that met with in average shop work, he could fill in the word "normal." In all cases where data of this kind are given, a statement should be made as to whether the work is done by the demonstrator or the customer's own operator.

At the completion of each demonstration, the demonstrator should also submit a report to the home office, setting forth, in a brief statement, the work done and the production obtained. A special form ought to be provided for this purpose, and the report should be signed by the customer's superintendent or foreman, so as to indicate that the machine has been demonstrated to his satisfaction.

The Attitude of the Service Man

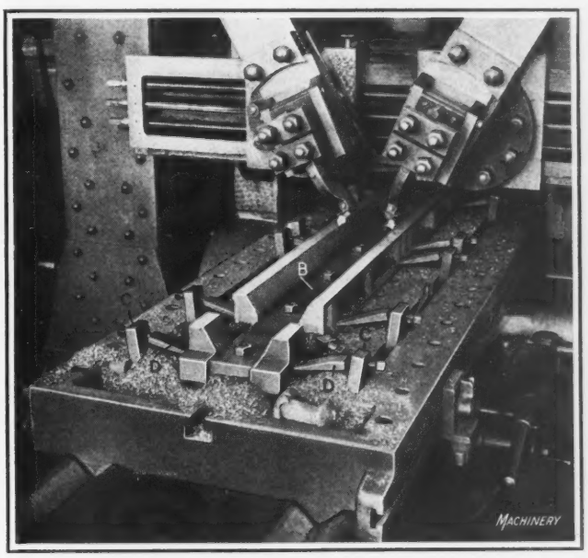
The attitude of the service man has much to do with the creation of a favorable impression of the service being rendered. Very often a customer calls for help when he is unable to correct a fault, simply because he is not looking in the right place for the cause. The service man or demonstrator should in all cases examine all the facts, and should accept no statements without having convinced himself of their accuracy. Erroneous statements are often made through lack of knowledge of the construction of the machine or by mistaken or erroneous assumptions. In investigating all details for himself, the demonstrator, of course, must use tact, but the acceptance without question of the user's statement of the cause of some unsatisfactory performance is likely to lead to delay in finding the remedy and to confirm the impression of faulty construction or design. As an example it may be mentioned that when unsatisfactory results are obtained in the use of a certain cam grinding equipment, it is natural to place the blame on the grinding of the master cams. As a matter of fact, the real cause of the difficulty is nearly always the alignment of the centers, speed of revolution, grade of wheel, or similar simple errors—something that is entirely in the hands of the customer's own operator.

Tendency to Overdo Demonstration Work

It may not be out of place to emphasize again the point that a great deal of needless expenditure of time and money results from offering the services of a demonstrator when the customer does not need his help. Some machine tool builders have on their quotation sheets a statement to the effect that when the machine is set up or ready for use a demonstrator will be sent to instruct the customer's operator without charge. While it should be understood that such service is available, it is hardly necessary to have this accompany every quotation. The services of a demonstrator will be furnished without charge in case the customer needs it, but many needless trips will be saved by not making this offer except when it is clear that there is a good reason for sending a demonstrator.

PLANING SLIDE GIBS FOR WOOD MOLDING MACHINES

The accompanying illustration shows a Niles-Bement-Pond planer equipped for finishing the slide gibs on a wood molding machine. This planer is used in the Pratt & Whitney Co.'s plant. The chief point of interest in connection with this operation is the provision made for setting up the work and locating the tool-heads so as to plane the slide gibs at the required angles. At the front end of the planer table, there is a templet *A* which has two inclined faces that match the contour of the surfaces that have to be planed on the work. In setting the tool-heads, it is the practice to locate the points of the cutting tools on these two inclined templet faces and to adjust the angles of the heads so that the tools may be fed along and kept constantly in contact with the templets. In addition to their use for setting the tools, these templets constitute a means of checking the accuracy of the finished surfaces of the work, the reading of an indicator in contact with the templet being compared with that of an indicator in contact with the finished face of the work. In this manner the planer operator can easily ascertain whether the job has been finished to the required form.



Application of Tool-setting Form in planing Irregular shaped Pieces

There is nothing of special interest in regard to the setting up of these castings for planing. It will be noticed that extending back from templet *A* there is a bar *B*, the sides of which are carefully finished to make them parallel, and as the inside vertical faces of the work have already been planed, they can be located against these parallel sides of the central portion of the fixture. Only the front end of the planer table is shown, but it will be apparent that the work is comparatively short and that a string of pieces is set up at each side of the parallel bar *B*. The ends of the first pair of castings at each side of this bar will be seen just back of the points of the cutting tools.

The method of clamping the work is quite simple. It will be seen that stops *C*, carrying clamping bolts in their upper ends, are placed in the table T-slots; and that fingers or so-called "butters" *D* are inclined downward, so that the pressure of the clamping bolts on these fingers serves the double purpose of pushing the work against parallel bar *B* and of holding it down on the table. On this job the depth of cut is ¼ inch, with a feed of 3/16 inch per table stroke, and a cutting speed of 35 feet per minute.

* * *

The French Government is encouraging the use of tractors for agricultural work, and granting loans for the purchasing of tractors and tractor material.

PRESS EQUIPMENT FOR FASTENING AND CLOSING PERFORATED CAN CAP

By S. A. McDONALD

The equipment employed on a horn press for securing a cap on the neck of a talcum powder can, and at the same time closing the sprinkling holes so that the powder will not sift out is shown in Figs. 1 and 2. The top of the neck fits loosely in the hexagonal-shaped cap, so that the latter may be moved around sufficiently to bring the perforations out of line. The horn press used for the fastening and closing operation is equipped with a hexagonal turret operated by a Geneva wheel which receives its motion from the brake end of the crankshaft.

The holder *A*, Fig. 1, has a hole through the shank, and a spiral threaded stem *B* is babbitted in place in this hole. On the end of the stem is a pad *C*, having a recess at *R* which fits loosely over the hexagonal-shaped cap. A ring *D* is secured to the punch, which acts as a guide for the pad *C* and the leather-faced pressure pad *E*. It also contains the trip-lever *F*, which engages the catch-screw *H* to hold pad *C* up until the end of the up stroke is nearly reached.

Six work-supporting horns like the one shown in the lower view, Fig. 1, are secured to the hexagonal turret, each of which has a tapered mandrel *J*, on which the expanding

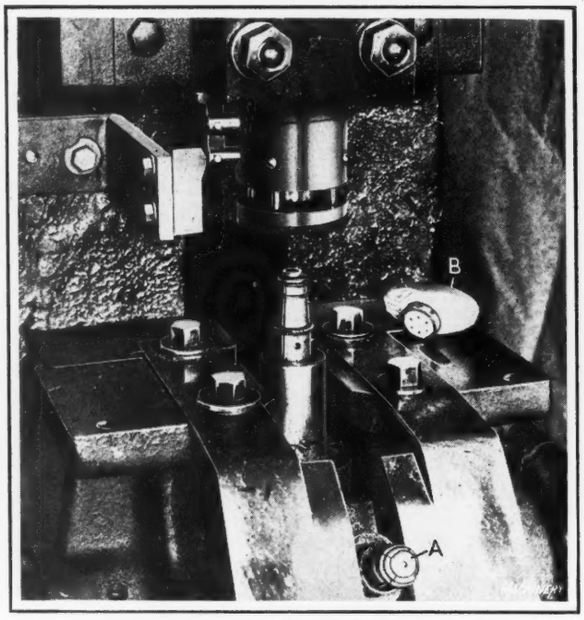


Fig. 2. Press equipped with Device shown in Fig. 1

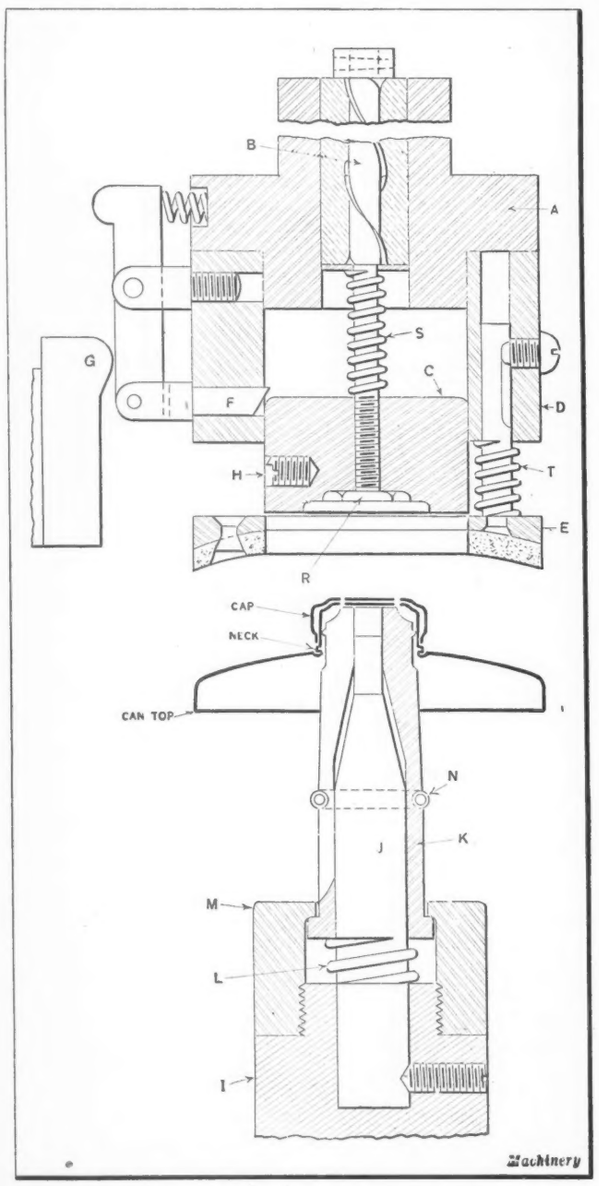


Fig. 1. Device for fastening and closing Perforated Can Cap

beading sleeve *K* slides. The spring *L* holds the sleeve in the upper position, and the nut *M* limits its upward travel. The small spring *N* serves to collapse the expanding sleeve. The trip-bracket *G* is attached to the body of the press by another bracket, as shown in Fig. 2. The operation of the device is as follows: When one of the turret tools or horns comes to the lower position shown at *A*, Fig. 2, the operator places an assembled can top, neck, and loose cap on the end of the expanding beading sleeve *K* of the horn in the position indicated in Fig. 1. At the next stroke of the press this horn comes under the punch, and when the punch descends the top and cap are located in their respective pads.

On the further descent of the punch the two pads stop, but the holder continues to descend, compressing the springs *S* and *T*, so that the pad *E* grips the can top while the pad *C* revolves, thus twisting the cap and closing the holes. When the pad *C* comes in contact with holder *A*, the spring *L* is compressed by sleeve *K*, and as the latter member slides down on the tapered mandrel *J*, it is expanded so that the bead sinks into the neck. This enlarges the neck so that the cap cannot be pulled off, but is free to revolve as far as the hexagon forms in the top will permit.

On the return stroke of the press, the pad *C* is retained or held up in the punch by means of the trip-catch *F* until its lever strikes the trip on the bracket *G*. Meanwhile, the pad *E* holds the can top down on the sleeve *K* so that the cap is free from the pad *C* and will not be turned to open the holes in the perforated cap. As the holder continues upward the trip releases the pad *C* and it spirals down to its lower position. The pad *E*, having traveled as far as its retaining pins will allow, moves upward, leaving the assembled work on the top of the now collapsed sleeve *K*. At the next stroke of the press, the assembled parts are carried in back of the press, where they tip off into a chute. One of the assembled parts is shown on the knee of the press at *B* in Fig. 2. As the operation is a continuous one an operator can assemble about 25,000 parts per day of eight hours.

* * *

Machinery manufacturers in Indianapolis are planning to take a large part in the Indianapolis Industrial Exposition, which will be held October 10 to 15, at the Indiana State Fair Grounds under the auspices of the Indianapolis Chamber of Commerce. Space has already been taken by more than 400 of the 781 different lines of manufacturing located in Indianapolis.

The British Machine Tool Industry

From MACHINERY'S Special Correspondent

London, August 16

BEYOND an improvement in the tone of inquiry, it cannot be said that the condition of the machine tool industry has altered since my last month's letter. There have been instances of orders booked for heavy machine tools, and some of the makers of these, particularly in the Manchester district, have been able to work full time. Judging from the latest of the inquiries received, there is a probability of a greatly increased trade with Japan, and not only there but in other prospective foreign markets much is being done to stimulate trade by improvement in British catalogues and other aids to sales. The absurdity of sending descriptive matter in a language that cannot be read by the potential purchaser is now recognized. Nothing is helping the overseas trade more than the cooperative trading policy, whereby firms act together as one concern in everything except the actual manufacture of products, and here they each agree to keep to that class or type of machine tools with which they have had the most experience.

Demand for Machine Tools in Domestic Market

There is a phase of the automobile industry that is bound to react favorably on the machine tool and small tool trades. Some of the makers who have previously confined their efforts to the production of the more luxurious cars are now interesting themselves in light cars that appeal to a much wider class of users; taking into account the many other concerns that cater for this trade there is no doubt that keen competition will call forth the most rigorous investigation and recasting of production methods. In the Birmingham district, there is some demand for machine tools for the brass trades, while in most districts it is clear that the small tool trade is quickly recovering. The Sheffield steel works are gradually returning to full activity.

It is reported that an order for 45 large locomotives, 2500 cars, and 12,000 tons of rails has been placed by New Zealand with British firms. A further order is also expected from the New Zealand Government for equipment for hydro-electric works, seven million pounds having been appropriated for that development. Some important Indian railway contracts have also been placed with British firms, and the low price at which the orders were taken points to an intention on the part of British manufacturers seriously to meet foreign competition. Part of the contract mentioned is for 135,000 tons of steel rails, and was taken at a price of about £10-2-6d (about $36.45 present exchange) per ton. This price is 15 per cent below Belgian quotations, but 3½ per cent above German quotations.

Imports and Exports of Machine Tools

Exports of machine tools in June show a small but welcome increase; the exports are valued at over £260,000 (about $936,000, present exchange) a figure that dwarfs the £40,000 ($144,000) value of imports. The fall in the value per ton of imported machines that was so strikingly pronounced in April and May was continued in June, the value per ton of both imports and exports being now about £150 ($540). This sudden fall in the import ton value from about £275 in only three months is very remarkable, and has occurred in a period during which the tonnage imported has remained fairly constant at a little over 200 tons per month.

During June no fewer than 246 lathes of a total value of nearly £100,000 ($360,000) were exported from Great Britain, while the most important items figuring in imports were 150 drilling machines of a total value of under £3500 ($12,600) and 78 presses, punches, and shearing machines totaling £17,600 ($63,360) in value.

New Developments in Small Tools and Special Machinery Field

The activity in the small tool trade is reflected in the large orders for twist drills being received by Tidswells Ltd., Ancoats, Birmingham. The methods used by this firm differ from those of other manufacturers in that the flutes are formed, and the backing off done after hardening. More uniform hardness is claimed and the number rejected is reduced, as naturally the plain round bar hardens with less distortion than a finished twist drill.

There are several plants requiring special machinery under construction for the quantity production of specific articles. One such plant is for the manufacture of door hinges; the equipment consists chiefly of special milling and drilling machines, and an output of 300 complete hinges per hour is arranged for. Another such plant is for the manufacture of sewing machines. These are designed to be made to sell at under 30s ($5.40) retail.

Prices of Materials

The uncertainty of material prices is having a detrimental effect on business generally. Users are buying only enough to just tide them over immediate needs. The iron and steel trade in consequence remains lifeless. Production of pig iron is negligible, smelters preferring to wait until they know what fuel prices are likely to be. Home supplies of pig iron are practically sold out, and weeks must elapse before furnaces can be got into regular production again. Meanwhile, many of our foundries are becoming familiar with foreign iron, where previously the practice has always been regulated by the employment of certain makes or mixtures of pig iron obtained at home. Modifications in their casting arrangements have been effected, so as to adapt them to imported material, and during the last three months Belgian iron, in particular, has made such rapid headway that it has established a position for itself from which it will be difficult to dislodge it.

The increase of about 5s (90 cents) per ton for coal is particularly unfortunate when the whole question of material prices hinges on this dominating factor. Everyone is agreed that nothing but substantial reductions in fuel charges can effect a lasting trade improvement and enable manufacturers to meet competition. Generally speaking, iron and steel prices have varied little during the last month, and the same is true of other metals.

* * *

REGIONAL MEETING OF THE A. S. M. E.

On October 3 to 4 a regional meeting of the American Society of Mechanical Engineers will be held in Cleveland, Ohio, with headquarters at the Hotel Winton, in the rooms of the Cleveland Engineering Society. Several papers will be read, and among others one by E. J. Lees, president Lees-Bradner Co., Cleveland, Ohio, on grinding and measuring involute gear teeth. The local sections and engineering clubs of the following cities have been invited to participate in this meeting: Akron, Buffalo, Chicago, Cincinnati, Cleveland, Columbus, Detroit, Erie, Rochester, Toledo, Indianapolis, Ontario, Pittsburg, and the Engineering Society of Dayton.

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THE "NEARLY HUMAN" MACHINE

Automatic machines of various types constitute one of the wonders of this wonderful mechanical era. Some automatic machines are spoken of as being nearly human. If any deserve this attribute, surely the machines used in making watches do. Some of these machines are illustrated and described in the series, "Automatic Machines in a Watch Factory" now appearing in MACHINERY. The sudden stopping and reversing of rotation, the indexing of the work-holding turrets, the timing and reversing of compound slides, and the various other mechanical movements, each governed by pneumatic control in turn actuated by auxiliary cams and levers, give to these machines such range and accuracy that they seem indeed to be more human than mechanical.

More and more mechanical devices automatically perform all the purely mechanical operations involved in production; but it is in the tireless, restless, and progressive human brain that these highly ingenious machines must first be conceived and fashioned. The thinking must be done for them—every step worked out.

Nor does the invention of these wonderfully productive machines injure even the workers directly replaced. On the contrary they are released from tedious, monotonous manual routine to render more interesting and useful service in channels requiring greater skill and ability where the automatic machine is still a stranger. The worker himself is advanced by invention which thus alters the character of his service, and enjoys the fruits of invention and progress to an extent undreamed of by the wealthiest and most powerful of a century ago. What would Napoleon have given for the twenty thousand Fords, owned by working men, which operate in and out of the single city of Detroit on a fair Saturday afternoon!

* * *

THE EXECUTIVE'S UNDERSTUDY

Carnegie is quoted as having said that he considered himself a good executive because he could leave his job at any time without being missed. He had selected such men and built up such an organization that if he were temporarily absent, everything would proceed along the lines laid down. It is all too well known that this could not be said of a great many manufacturing organizations. Very often production is under the supervision of a factory manager or superintendent who personally attends to a great many details without consulting to any extent with assistants or department foremen. So long as the man entrusted with this work is on the job everything goes well; but too much dependence is placed upon his being constantly on the job; and if he takes to his bed with a long illness, goes on a vacation, or leaves for another job—any of which is likely to happen—confusion generally reigns for a while until someone else, after many mistakes, is trained for the responsibility.

Every organization should have an understudy working with every man who is holding a position of responsibility. The understudy should do the actual detail work, so as to learn all about policies and details, and be able, temporarily at least, to fill the position of his superior. This is the only way in which to give an understudy the training that he must have to permanently fill the position, should a change become necessary. Progressive and prosperous businesses often suffer greatly through losing the services of some executive who had no capable understudy.

In a small shop a single understudy would be sufficient. In a large shop it would be better to have a number of men trained under the direction of the chief executive. One large manufacturing plant has created an advisory board of assistant superintendents, half a dozen in number, to work under and in consultation with the general superintendent. The duties and responsibilities of each of these assistant superintendents are defined so that the foundry, pattern, and drafting departments come under one man; the die, tool, jig and fixture work under another; the assembling, shipping, bench, and repair work under another; all the production machine work under another, etc. By this method the general superintendent is relieved of a great deal of minor detail and can devote himself to the bigger production problems; while on the other hand, the men working directly under him become trained in handling executive problems. Should the factory manager take sick, die, or leave, there would be a group of trained men from whom the most capable could be selected to fill his place.

We have been so busy producing during recent years that we have almost forgotten how to train men for executive positions, but there is ample evidence that our manufacturers are awakening to the great necessity for regular and systematic attention to this very important organization problem.

* * *

TRADE SCHOOL EQUIPMENT

Generally speaking, machine tool manufacturers show very little interest in the equipment of trade schools. This field has been left largely to a few manufacturers specializing in machinery for trade schools, but it would be to the interest of the entire machine tool industry if trade schools were equipped with a greater variety of standard machine tools. Young men who receive their education in these schools pass out into active shop work, and many of them become executives later. They always remember the names of the makers and the characteristics of the machines used during their training period. For this reason alone it is decidedly to the interest of machine tool manufacturers generally to have their machines used in trade schools.

In selling surplus machine tools at 15 per cent of the purchase price to trade and engineering schools, the Government greatly aided many to obtain an up-to-date and varied equipment, and hundreds of machine tools that otherwise never would have found their way into such schools were thereby placed to the great advantage of engineering education. One town in the Middle West alone acquired $200,000 worth of these machines for its trade school at the comparatively small cost of $30,000. Some of these machines were new, and some very slightly used. But in cases where additional auxiliary equipment was required, the trade school authorities complain that they received little encouragement or help from the manufacturers, and that the makers were reluctant to give them the aid of their service departments. Ordinarily, buyers of second-hand machinery are not entitled to free service, but in the trade school where the future executive makes his acquaintance with the tools of the machine building industry, it is of lasting value for the manufacturer to have his machines operate satisfactorily.

The Present Situation and the Outlook

Summarizing the Views of MACHINERY'S Correspondents

THE many interesting letters in the symposium by practical business men published in July and August MACHINERY give a clear idea of the trend of thought in the machine building industry. The note of confidence, the definite constructive suggestions, the forward-looking attitude, the clear recognition and concise statement of the salient facts—all are equally significant. It is well worth while to glance again at the views so definitely stated; to note the quite unanimous opinion that improving business is just around the corner. Here are some quotations:

"I have been in the machine tool business for thirty years; I have seen its ups and downs periodically, but I have never lost faith in it."

"No one will believe that the human race is going to stand still very long."

"A good, healthy, reliable business that takes care of the normal requirements of our people is what we want and is what we are going to have in the near future."

"Do not overlook the thousands of new devices invented every year to replace hand labor, such as office appliances, household conveniences, sporting goods, toys, etc., all of which require machine tools in great quantities."

"We should not forget that in the long run everything points to the continually increasing use of machinery to replace manual labor in the factory, on the farm, and in the household. This calls for an increasing amount of machine tools, and the machine tool industry is always certain of its place in the economic structure."

"The most pressing needs of the industry are: the effecting of economies in our organizations, the still further perfection of design, and unfailing confidence in its ultimate future following the readjustment, when the resumed demand for things mechanical will inevitably be felt. This is no time for discouragement as to the future."

Definite opinions clearly expressed, straightforward advice, and practical suggestions—that is what the leaders in the machine tool industry gave to each other and to the industries in general in the symposium published in July and August MACHINERY. Manufacturing and selling problems must be solved, and the broad and candid exchange of ideas is now the most valuable form of cooperation in industry. This brief summary gives some of the salient points emphasized by responsible men now guiding their ships through the uncertain sea of business depression. The chief note is one of confidence and assurance.

The following definite statements as to the return of more active business in the machine tool industry came from men of long experience:

"I am convinced that we have turned the corner and that before many months we shall have the definite evidence of another era of prosperity."

"The last three months of this year will probably be fairly good months in the machinery line. Beginning in January, 1922, I am looking forward to good, normal, healthy business which will probably last for several years."

"I believe there will be a gradual revival of business in the fall, and in a year from now the purchasing power of Europe may be enough improved to make the machine tool business in the United States about normal."

The keynote of many letters was the importance of using the present slack time to lay definite plans for the future—for improving the product so as to be ready for business when it resumes its full volume. Emphasis was laid on this, especially by men whose success in the machine tool field entitles them to more than ordinary attention:

"The present pause in the industry presents an excellent opportunity to make plans for the future. This is the time to bring equipment and methods up to date. The manufacturer who does this most effectually will have least cause for worry in the days of hard competition impending."

"We all need a period of quietness in which we can check over our designs and our methods of manufacture. The machine tool builder who is not looking into the possibilities of specializing on some class of tools which will reduce the cost of production is losing a great opportunity."

"Increased production is obtained principally by or through efficient machine tools. Big opportunities are not far off for the machine tool builder who has a line of machines for intensive production, for when the tide turns it will be on greatly reduced cost."

"The manufacturer who makes a product of superior quality, and is prepared to give service, is going to reap a reward with the revival of business that is sure to come."

The reduction of production costs is the dominant thought in industry and will be in the years to come. It is also the dominant thought among the men who control in the machine tool industry. To quote from their letters:

"We believe that the words of Charles M. Schwab: 'Now is the time for the business-man to concentrate attention on the cost-sheet and not on the profit statement' should be given serious thought by every executive."

"The outstanding feature of the present machinery trade situation is the vital necessity for radical cost reduction."

"Cost cutting machinery and methods must be installed in both large and small shops of all industries in order that low production costs all along the line will permit of normal sales prices."

"A large number of concerns which manufacture in quantities are waking up to the fact that special machines and special tools will give them a much larger output per man-hour—sufficient to warrant the purchase of new and improved equipment."

"We are now entering upon a period of competitive production, in which the fittest to survive will be those who produce either better quality for a given price, or, by more efficient tooling, a satisfactory product at a lower price—or both."

The necessity for adequate publicity was touched upon by some of those who contributed to the symposium. Effective publicity is one of the sure factors of success, and has counted heavily with many of the leading manufacturers in the machine-building field:

"The very last asset a business man can dispense with, in these times of restoration, is his advertising program."

"The time to treat publicity matter as a side issue is past; and with a clear conception of the obstacles to be overcome, the results will more than justify the expenditure."

"Advertise and let the people know what you have, and do it now when they all have time to read your message. Don't do it with a splurge and then quit; you may quit just at the time when the man who wants your product has made up his mind to buy."

The quotations given are typical of the ideas expressed in most of the letters received. If space permitted, the number of extracts well worth repeating could easily be doubled. Every section of the country where tools and machine shop equipment are made was represented in this symposium. The selections sum up the conclusions for MACHINERY'S readers, and it will be interesting and doubtless stimulating to watch developments in the light of these authoritative opinions as to the Situation and the Outlook.

Instructions for Designing Fixtures

By H. P. LOSELY, Industrial Engineer, James E. Morrison Co., Detroit, Mich.

MANY tool-drafting departments make a practice of supplying checkers with instruction sheets enumerating all points on the finished design requiring checking. This is a good idea, but, why not give the instructions to the designer in the first place so that he may discover mistakes and omissions long before the drawings reach the checker? The instructions here presented have been compiled for the purpose of educating young designers of fixtures and reminding more experienced men of certain fundamentals which should be observed. These have been condensed into the seventeen major points shown in the accompanying list. The various points mentioned in the list will be dealt with more fully in the following, the same numerical order being maintained:

IMPORTANT POINTS IN FIXTURE DESIGN

1. Draw part to scale corresponding to latest blueprint and operation sheet.
2. Consider the condition of locating surfaces and the tolerances allowed.
3. Provide for the easy insertion and removal of work.
4. See that the piece will not be distorted by clamps or tool pressure.
5. Provide for the disposal of chips.
6. Do not require more than one wrench to operate the fixture.
7. Make a rapid-operating fixture.
8. Avoid a complicated construction.
9. Make the fixture to suit the machine.
10. Make a stable and rigid fixture.
11. Design to facilitate the set-up on the machine.
12. Make castings as simple as possible.
13. Use machine steel whenever it is economical.
14. Make sure that the tools can operate in the required position.
15. Picture mentally the whole operating process to see if all accessories are provided.
16. Use standard parts, castings, and stock material.
17. Consider the safety of the operator.

1. Examine the operation sheet to determine the condition of the piece prior to the operation for which the fixture is intended, and then draw the piece according to this actual condition. If the piece is unsymmetrical, take care to show it drawn to the correct "hand" and to scale; then check carefully before proceeding further with the design, as any errors in the scale of the drawing of the work, may cause the rejection of the whole design.

2. Pay attention to the condition of the surfaces or points from which the piece is located, and design the fixture to suit the tolerances allowed. If locating from a rough surface, design so that an adjustment can be made to suit the casting or forging. When locating from holes, note whether they are drilled or reamed and make the locating plugs to suit. If locating from rough- or finish-machined surfaces, note the limits allowed and consider the effect on the position of the piece.

3. Design the fixture so that the work can be readily inserted and removed, and leave ample clearance between the piece and any walls or other parts of the fixture. If the fixture is to be used much, do not hesitate at some extra expense in making the loading and unloading easier.

4. Make the clamping and supporting arrangements strong and stiff enough so that the pressure of the tool cannot move or distort the piece, and design the fixture so that it will withstand rough use.

5. See that the chips can get away from the cutting point without choking, and make the locating surfaces so that they can be readily cleaned before putting in the work. If cutting compound is to be used, it may be necessary to provide a retaining wall, and, if this is done, arrange so that the level of the wall will be at the right height, making an outlet at some point where the flow of compound will not be objectionable, or providing a pipe line to carry it back to the pump. In this case pay particular attention to avoiding pockets which will make it difficult to clean the fixture. If a retaining wall is not required and a heavy stream of compound is used, make an inclined surface or channel so that the stream will automatically wash the chips away.

6. All screws used in operating the fixture should have the same size of head so that one wrench will suffice for tightening the piece. If possible, avoid plain heads altogether and use wing-nuts, hand-knobs or plain heads with a heavy pin through them so that the screw can be tightened by a hammer-blow.

7. Make the operation of the fixture as simple as possible. Provide springs to bring clamps and levers back against the screws operating them; provide stops against which to run tools or open lids; use cams in preference to screws whenever practicable; and otherwise make the fixture so that the time consumed in changing the work is reduced to a minimum. On quantity production this is important, as the output of the machine may be greatly influenced thereby.

8. Avoid a complicated construction. While rapid operation is desired, frills are to be shunned, and any construction likely to get out of order or cause operating trouble, will never be acceptable to the shop. In any case, keep the cost of the fixture in proportion to the operation that is to be performed.

9. Look up the data of the machine on which the fixture is to be used and make the fixture to suit. See that operating clearance is provided, and that no interference with feed handles or the machine column exists. Check up the position of the tools and their range of action to see that the range of the machine feed is sufficient.

10. Make the base large enough for the fixture to be stable and free from any tendency to rock. Make the body, walls, and ribs heavy enough to insure rigidity, but do not make them excessively heavy, especially if the fixture is one which must be moved around.

11. If the fixture must be fastened to the table, provide ample facilities and such locating elements as keys in a milling fixture to fit the table slots, pads against which to set feeler gages, a machined circular surface to indicate the position of the faceplate fixture, etc.

12. Where a complicated casting would otherwise result, make separate brackets which can be screwed and doweled on the body. Remember, however, that the simplest bolting-

on job takes at least two hours' work in the tool-room to square up faces, drill, tap, and ream the required holes, and fit the screws and dowels, so that it does not pay to bolt on a separate piece to avoid one simple core. Wherever cores and loose pieces on the pattern can be avoided, choose the simple casting rather than the good-looking one.

13. Do not use a special casting for a piece which may readily be made from machine steel. On the other hand, if the making of a piece from machine steel entails a great amount of roughing out, it is better to make a pattern for producing a casting than to tie up a machine in the tool-room for a few hours.

14. Show the outlines of arbors, drill chucks, or any other small tools in the assembly drawing to make sure that there is no interference and that the distance from the table to the cutting point is within the range of the machine.

15. Consider the actual operation of the tools and fixture, and see that all accessories have been supplied. For instance, if support arms are required on a milling job, they should be shown in the assembly drawing, together with arbor collars and cutters. Furthermore, the list of tools to go with the set-up should be checked.

16. Use standard parts and castings whenever practicable, and when using machine or cold-rolled steel, consult the stock lists and design so as to utilize stock material with a minimum of machining. The designer should familiarize himself with the material carried in stock and listed in the drafting-room catalogue.

17. Have some consideration for the man operating the fixture. That the fixture should be designed so as not to endanger the operator goes without saying, although some designers neglect this point once in a while. On faceplate fixtures for a lathe or grinder particularly, do not omit a circular guard for covering any moving projections and provide against latches, etc., flying open. Supply ample clearance on all hand-knobs and levers so that the operator need not be particular in grasping them lest he scrape his knuckles.

* * *

TAXATION OF U. S. CITIZENS DOING BUSINESS ABROAD

The National Foreign Trade Council, India House, Hanover Square, New York City, has published a pamphlet entitled "The Unwisdom of Taxing the American Trader in Foreign Countries," containing an argument in favor of exempting Americans living and doing business abroad from taxes payable to the United States on income derived within the foreign country.

Citizens of the United States living and doing business in a foreign country are placed at a tremendous competitive disadvantage, because they are forced to pay to the United States a tax on income derived from their work and business in the foreign country. No country except the United States taxes its citizens living abroad on income derived from foreign sources.

It is true that the United States allows its citizens to credit against these taxes the total of all income and excess profits taxes paid to foreign countries upon income derived from sources therein, but this still places the American doing business abroad at a competitive disadvantage. On a business income of $500,000, the difference against the American trader, that is, the excess of taxes paid by him, may vary from $242,000 to $375,000. As an example, it is mentioned that there is a French concern in Manila handling American automobiles and tractors. In 1919 this company earned a net profit of $600,000 on which it paid a tax to the Philippine Government of $77,735, but paid no tax to the French Government. An American concern doing the same business in Manila would have to pay a total of $375,190 in taxes, or nearly $300,000—one-half of their net profit—in excess of what the French concern had to pay.

CONDITIONS IN THE GERMAN METAL INDUSTRY

Factories making the following lines of goods are reported to be well occupied: Locomotives, railway cars, shipbuilding, internal combustion engines, paper-making machinery, and woodworking machinery. All other industries are either working on stock or with reduced time. The iron and steel industry is in a critical position, and can sell only part of its production, in spite of the fact that it is short of raw materials, using in some cases cheap Spanish ores. By losing Lorraine and separating the Saar district from Germany, as well as separating Luxemburg from the customs union, Germany has lost 75 per cent of its ore supplies, 40 per cent of its blast furnaces, and 30 per cent of its steel and rolling mills. Prices have been cut 50 per cent without reducing wages, but it is stated that further reductions can be made only if the workers themselves voluntarily give up the legal eight-hour day. Up to the present time the workers have refused. On the first of April 887,000 men were reported out of work. A report issued by the Allgemeine Elektrizitäts Gesellschaft, covering plants employing 2000 officials and office people and 11,000 workmen, indicates that since 1913 wages, as expressed in marks, have been increased so that they are eight times what they were then.

News of the German Machine Tool Industry

Sondermann & Stier of Chemnitz have made an agreement with the machine tool works of Karl Wetzel of Gera and the Union Works of Chemnitz, according to which Sondermann & Stier will devote themselves entirely to boring and turning mills, and drop the manufacture of horizontal boring and milling machines, which latter line will be made a specialty of by the Union Works for machines up to a 3-inch diameter spindle, and by Karl Wetzel for machines with a spindle diameter of more than 3 inches. The three firms will also exchange all technical knowledge and experience with each other, have consolidated selling organizations, and will occupy a leading position in their branch of the machine tool industry.

Fritz Werner of Berlin-Marienfelde, employing at present 1000 men, is working exclusively on stock. The plant, however, is large enough to give employment to double the number or more. The foundries of these works have a daily capacity for 30 tons, all of which is not machine tool castings. The Fritz Werner Works are now manufacturing a large vertical milling machine. The Ludwig Loewe Co. reported for last year a net profit of 4,860,000 marks, and paid a dividend of 21 per cent. This company is now working exclusively on stock.

Very interesting tests are being carried out by the Berliner Präzisionswerke with the use of liquid air in relieving the internal stresses of tools, gages, and measuring instruments. It is said that the firm has obtained good results by chilling the material from which the tools are made to 80 degrees C. below zero.

Some interesting news comes from Austria. A prominent German leader in the iron and steel field has acquired an important interest in one of the large Austrian iron and steel works, which before the war produced 600,000 tons of pig iron and 500,000 tons of steel annually. Coke will be supplied from Germany, and it is expected that this transaction will mean a turning point in the whole Austrian iron and steel industry.

It may be of interest to note the varied lines of business to which the large number of German airplane manufacturers have turned. Taking ten of the leading of these manufacturers we find that they have entered such fields as the making of motor boats, electric railways, elevators, traveling cranes, locomotive and car repairs, bedsteads, milk separators, bicycle rims, driving motors for bicycles, motorcycles, agricultural machinery, domestic electrical apparatus, and furniture.

AMERICAN GEAR MANUFACTURERS' INSPECTION STANDARDS

At the annual meeting of the American Gear Manufacturers' Association, the following inspection standards were adopted as recommended practice:

Cylindrical Holes

Cylindrical holes up to 3 inches in diameter should be inspected with "Go" and "Not Go" plug gages, the diameter of the "Go" end being the same as the smaller limit specified on the customer's drawing, and that of the "Not Go" end, the same as the larger limit given. For holes between 3 and 12 inches in diameter, the gage should consist of two bars placed approximately at right angles to each other and held together by a handle, pressed through a hole in the middle of each bar. One bar should be made to the "Go" dimension and the other to the "Not Go" dimension. The length of the handle and the question as to whether the bars should be placed close together or at opposite ends of the handle will depend upon the nature of the work and principally upon the length of the hole. Holes larger than 12 inches in diameter should be inspected by means of measuring rods, inside micrometers set to vernier calipers, or a standard measuring machine. Gages should not be used after their wear has exceeded the limits on a customer's drawing.

Tapered Holes

Tapered holes should be inspected by means of taper plug gages, the quality of fit being determined by lightly coating the gage with red lead or Prussian blue. A full bearing should be shown. The proper depth of reaming or grinding of the hole should be indicated by means of a stepped shoulder located at either end of the plug, as the case may require, the height of the step and the relationship to the taper, agreeing with the limits specified on the customer's drawing.

Keyways in Holes

Single and multiple keyways in straight and tapered holes should be inspected for width by using "Go" and "Not Go" flat limit gages. For alignment and depth, a plug gage should be employed, the body diameter of which is the small limit of the hole and which has a key or keys, as the case may be, long enough to reach the entire length of the keyway. The width and height of the key gage should agree with the low limit specified. If the maximum depth is important, a similar gage should be used as a "Not Go" gage. This gage should have a key height equal to the maximum dimension given on the customer's drawing.

All keyways for Woodruff keys should be inspected by using a hardened gage similar in shape to the Woodruff key used, but slightly thinner than standard. A keyseated ring gage should be slipped over the key when the latter has been placed in the keyway. Two keyseats may be put in the ring gage to agree with the depth limits on the customer's drawing. For width of keyway, a "Go" and "Not Go" flat limit gage should be used, the dimensions of both ends of which should agree with the limits specified.

Shafts

Splined shafts should be checked for width of spline and root and outside diameters by "Go" and "Not Go" snap gages made to the dimensions given on the customer's drawing or with micrometers set to the same dimensions. For accuracy of spacing, a ring gage should be employed, which should have one portion of the hole ground to the minimum diameter of the keyways of the mating member, an annular portion at one end with a diameter of hole equal to the maximum diameter of the shaft body, and should be milled and ground away so as to obtain projections the cross-sectional dimensions of which will be the same as the minimum space allowed between the keys.

Inspection Standards for Shifter Grooves

Shifter grooves should be inspected for diameter by using a "Go" and "Not Go" snap gage, slightly thinner than the width of the groove and made to the dimensions specified on the customer's drawing. Shifter grooves may also be inspected by means of a micrometer. If a fillet is required at the bottom of the groove, a similar allowance plus a small amount for clearance, should be provided in the snap gage. A "Go" and "Not Go" flat limit gage, made to the limits specified on the customer's drawing, should be used for testing the groove width.

Small Sizes of Spur, Spiral, and Internal Gears

Small sizes of spur, spiral, and internal gears should be inspected on hand fixtures for pitch diameter, eccentricity, and irregularity of teeth. The fixture should be rigid in construction and have one stationary and one freely sliding head, the latter being so arranged that its movements will actuate a dial indicator. It is preferable to use a hardened and ground master gear of proved accuracy. The studs on which the work and master gear are mounted should be at right angles with the surface on which the sliding head moves and parallel with each other within 0.002 inch in a length of 12 inches. The diameter of the work stud should not be smaller than the low limit of the plug gage used in testing the hole in the work, while the stud for the master gear should be about twenty-five hundred-thousandths inch less in diameter than its hole. This fixture may also be used for determining the quality of tooth bearing.

For the determination of noise, a power-driven fixture should be resorted to, the requirements of which should be the same as for the hand fixture, except that it should be possible for one spindle to be rotated in either direction and the other spindle should be provided with a brake. No indicator should be furnished, and the movable head should be controlled by an adjustable screw having a micrometer collar. A clamping screw should be provided for locking the movable head. Master gears of 6 diametral pitch and finer should be true within an eccentricity tolerance of 0.001 inch. In disputes concerning eccentricity when master gears of proved accuracy are not available, a hardened gear with teeth cut away so as to have but one tooth in engagement at a time may be used by rolling it through the arc of contact and then ratcheting to the next tooth to be inspected.

Bevel Gears

Bevel gears should be inspected on hand or power-driven fixtures for quality, and on reversible power-driven fixtures equipped with brakes for noise. These fixtures should also be rigid in construction, and the belt pull should be downward rather than upward so as to seat the movable head, rather than to pull it away from the bearing surfaces. The spindles should lie in the same plane and be at right angles to each other within an error of 0.002 inch in 12 inches. With straight-tooth bevel gears, conical pointers may be used to ascertain whether the teeth are radial or not. The foregoing applies to such gears as are used in automotive constructions and not to the larger mill gearing.

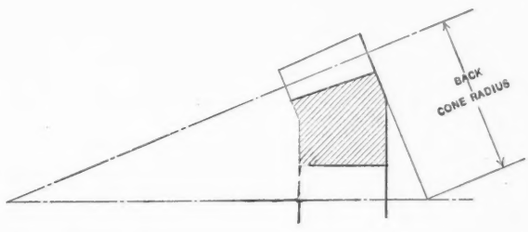
Questions of tooth bearing should not be determined in the final assembly in case of dispute, but by inspection on proper test fixtures. The holes in collets or bushings for holding stem gears should be equal to the maximum shaft limit plus the smallest allowance which will permit the stem to be entered. A satisfactory way of testing the backlash of gears is by the use of standard feelers. The backlash of an individual gear may be determined by substituting a master gear of standard thickness of tooth and pitch diameter in place of the mating gear.

Other standards and recommended practices adopted at the annual meeting of the American Gear Manufacturers' Association will be published in coming numbers of MACHINERY. The association is doing a very valuable work along standardization lines.

LONG AND SHORT ADDENDUM BEVEL GEAR TEETH

Tables giving the proportions of 14½-degree teeth for long and short addendum bevel and spiral-bevel gears of ratios between 3 to 1 and 8 to 1, were presented at the recent annual meeting of the American Gear Manufacturers' Association by the bevel and spiral-bevel committee of the organization, and were adopted as recommended practice. These tables are given herewith, together with a description of the manner in which the values were arrived at. Long and short addendum bevel gear teeth are treated in the same manner as similar spur gear teeth, with the exception

TABLE 1. MAXIMUM THEORETICAL ADDENDUM OF BEVEL GEAR TEETH WHEN THE PINION BACK CONE RADIUS EQUALS 1 INCH



Dimensions in Inches

Ratio of Gear to Pinion	Pressure Angles			
	Plain Bevel		Spiral Bevel	
	14½ Deg.	20 Deg.	14½ Deg.	20 Deg.
1 to 1	0.0899	0.1623	0.1159	0.2043
2 to 1	0.0699	0.1295	0.0909	0.1655
3 to 1	0.0659	0.1226	0.0859	0.1571
4 to 1	0.0645	0.1201	0.0841	0.1541
5 to 1	0.0638	0.1190	0.0832	0.1527
6 to 1	0.0635	0.1184	0.0828	0.1519
7 to 1	0.0632	0.1180	0.0825	0.1514
8 to 1	0.0631	0.1177	0.0823	0.1511

Machinery

that the back cone radii are used instead of the pitch circle radii. The pitch circles of a gear and pinion are shown in view *A* in the accompanying illustration, together with the base circle of the pinion as determined by the pressure angle *a*.

Contact of involute teeth cannot take place below the base circle, since the involute curve has its inception at the base circle. Thus, any projection of the addendum portion of a

TABLE 2. PROPORTIONS OF PLAIN BEVEL GEAR TEETH WITH PRESSURE ANGLES OF 14½ DEGREES FOR GEAR RATIOS BETWEEN 3 TO 1 AND 8 TO 1

(Values are for Gears of 1 Diametral Pitch)

No. of Teeth in Pinion	Addendum		Full Depth	Circular Thickness	
	Gear	Pinion		Gear	Pinion
14	0.560	1.440	2.157	1.186	1.955
15	0.600	1.400	2.157	1.221	1.920
16	0.640	1.360	2.157	1.256	1.885
17	0.680	1.320	2.157	1.291	1.850
18	0.720	1.280	2.157	1.326	1.815
19	0.760	1.240	2.157	1.361	1.780
20	0.800	1.200	2.157	1.396	1.745
21	0.840	1.160	2.157	1.431	1.710
22	0.880	1.120	2.157	1.466	1.675
23	0.920	1.080	2.157	1.501	1.640
24	0.960	1.040	2.157	1.536	1.605
25	1.000	1.000	2.157	1.571	1.570

Machinery

Dimensions in Inches

TABLE 3. PROPORTIONS OF SPIRAL-BEVEL GEARS WITH PRESSURE ANGLES OF 14½ DEGREES FOR GEAR RATIOS BETWEEN 3 TO 1 AND 8 TO 1

(Values are for Gears of 1 Diametral Pitch)

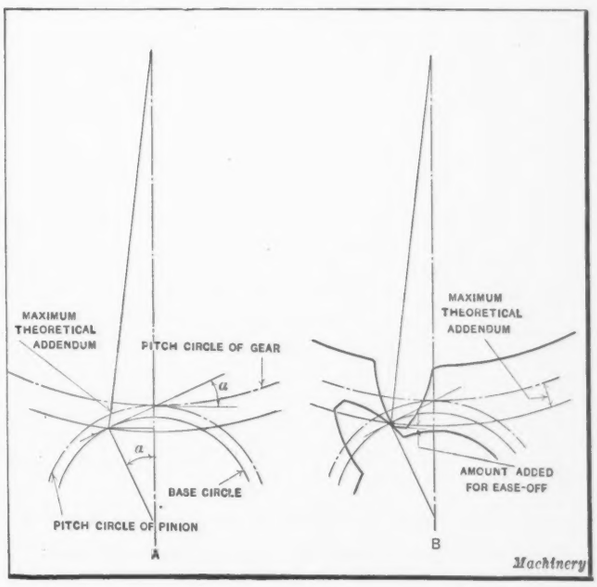
No. of Teeth in Pinion	Addendum		Dedendum		Full Depth	Circular Thickness	
	Gear	Pinion	Gear	Pinion		Gear	Pinion
10	0.500	1.200	1.420	0.720	1.920	1.2000	1.9416
11	0.550	1.150	1.370	0.770	1.920	1.2500	1.8916
12	0.600	1.100	1.320	0.820	1.920	1.3000	1.8416
13	0.650	1.050	1.270	0.870	1.920	1.3500	1.7916
14	0.700	1.000	1.220	0.920	1.920	1.4000	1.7416
15	0.750	0.950	1.170	0.970	1.920	1.4500	1.6916
16	0.800	0.900	1.120	1.020	1.920	1.5000	1.6416
17 or over	0.850	0.850	1.070	1.070	1.920	1.5500	1.5946

Machinery

Dimensions in Inches

gear beyond the base circle of the pinion at the beginning and end of the theoretical arc of action is useless so far as tooth action is concerned. The first problem is to find the gear addendum which at the beginning of the arc of approach extends to the base circle of the pinion. This is known as the "maximum theoretical addendum." Values for this addendum to suit various ratios and for 14½- and 20-degree pressure angles are given in Table 1; these values were obtained by calculating the opposite side of the smaller of the two triangles of which *a* is the acute angle. The values given are for gears of 1 diametral pitch, and for any other diametral pitch they must be divided by it. Examination of the table will show that the values between ratios 3 to 1 and 8 to 1 do not change greatly, and for the sake of simplicity in preparing the tooth proportion tables, it will be assumed that there is no difference.

Table 2 gives the dimensions for 14½-degree plain bevel gear teeth. The addendum in each case has been obtained



Diagrams used in determining the Proportions of the Gear Teeth

by adding a certain percentage to the maximum theoretical addendum to provide an "ease-off." The view at *B* in the illustration shows graphically that unless this percentage is added, the tooth load on the gear at the beginning of the approach will lie along the very top of the tooth, which is a condition to be avoided. The circular thickness, that is, the thickness of the tooth measured along the pitch circle, was in each case obtained from a lay-out giving consideration not only to the strength of the tooth, but also to the width of the top. The tooth widths are sufficient to prevent a complete carburization, and consequent brittleness, in casehardening.

The values given in Table 2 are also for gears of 1 diametral pitch, and must be divided by the diametral pitch of the gears being proportioned. No table has been compiled for gears of 20-degree pressure angles, as the standard proportions, where the addendum is one-half the working depth, have proved satisfactory when the number of teeth in the pinion is not less than twelve. For ratios below 3 to 1, the percentages of change are so great, as shown in Table 1, that a lengthy table would be required to cover properly the proportions of gears of these ratios.

Table 3 gives the tooth proportions of 14½-degree spiral-bevel gears of ratios between 3 to 1 and 8 to 1, this table being also for gears of 1 diametral pitch. The values were obtained in the same manner as for plain bevel gears, with two modifications—the working depth of spiral-bevel teeth is 85 per cent that of plain bevel teeth, which are of standard depth, and the bottom clearance is 0.07 times the circular pitch instead of the usual standard of 0.05 times the circular pitch.

* * *

GREATER EFFICIENCY NEEDED IN RAILROAD OPERATION

If there is to be an early revival of industrial activity, the transportation system of the country must be placed in a position to obtain the same efficiency in operation as any manufacturer running his own plant. Only by so doing will it be possible for the railroads to reduce fares and rates; and such a reduction is necessary if we are again to have real industrial prosperity. In view of this situation the National Founders Association, in common with many other groups of manufacturers in the United States, recommends and urges that the agreements made during Federal control by the Railroad Administration be completely abolished. The Labor Board has ordered the cancellation of these restrictive rules, but has ordered the railroads to make new agreements with various union crafts. Leaders of these organizations are demanding that the new agreements be practically identical with the ones made during government control. Refusal of the railroads to perpetuate all these rules—which it is estimated cost the transportation interests of the country more than $300,000,000 annually—means that the Labor Board will be called upon to decide the question, so that there is danger, unless a firm stand is taken, that conditions such as prevailed during government control will be made perpetual.

It is further urged that jurisdiction over questions of wages, classifications, and working conditions be restricted to the individual railroad administration. Rules and regulations made by the Government during Federal control, continued in effect by the Labor Board, have standardized wages and rules on all railroads without regard to living conditions in particular communities or the rates of pay of employes of other industries doing similar work in these communities. Workers should be paid according to the service they perform, as they were before the Government took over the railroads.

It is also demanded that Congress immediately repeal the Adamson Law, passed under duress and unquestionably one of the most hampering pieces of legislation affecting a legitimate industry ever enacted at Washington. The Adamson Act was not really a law governing hours of labor, but was essentially a wage measure, sought by the union leaders as a way to increase the pay of certain classes of railroad employes. To repeal it would enable the railroads of the United States to save enormous sums annually without impairing their service or doing an injustice to any employe.

* * *

The total export trade of the United States to India increased 147 per cent in value from 1918 to 1920. The value of the metal-working machinery exported in 1918 was $1,251,662, and $1,374,068 in 1920.

INDUSTRIAL CONDITIONS IN FRANCE

By MACHINERY'S Special Correspondent

Paris, August 11

There has been but little change in the industrial conditions during the last month. A slight improvement is noticeable in the automobile field, which is somewhat more active as a result of the reduction in the price of gasoline in France. The Renault plant is now producing 800 cars a month. A year ago 1200 cars a month were built, but the present output is considered satisfactory, as the firm is devoting part of its facilities to other branches of metal manufacture.

In the shipbuilding industry conditions are not as good as they were a year ago. One of the yards in the Loire-Inférieure district, established about a year and a half ago, has been closed down. The steel mills are still reducing the prices of materials. It was thought some time ago that the minimum had been reached, but that was not the case. A reduction of 20 per cent in the price of iron and steel is expected in Belgium in the near future. The German and Luxemburg metal manufacturers have made a further reduction in the price of steel bars.

As an indication of the price reductions, it may be mentioned that pig iron which was quoted last year at 650 francs (present exchange, $50.70) a ton, is at present marketed at 200 francs ($15.60) a ton, and a further reduction in price is expected. One of the steel companies is said to have sold pig iron as low as 150 francs ($11.70) a ton. In spite of these great reductions, there is but a small market, and furnaces are continually being closed down in the various iron and steel districts.

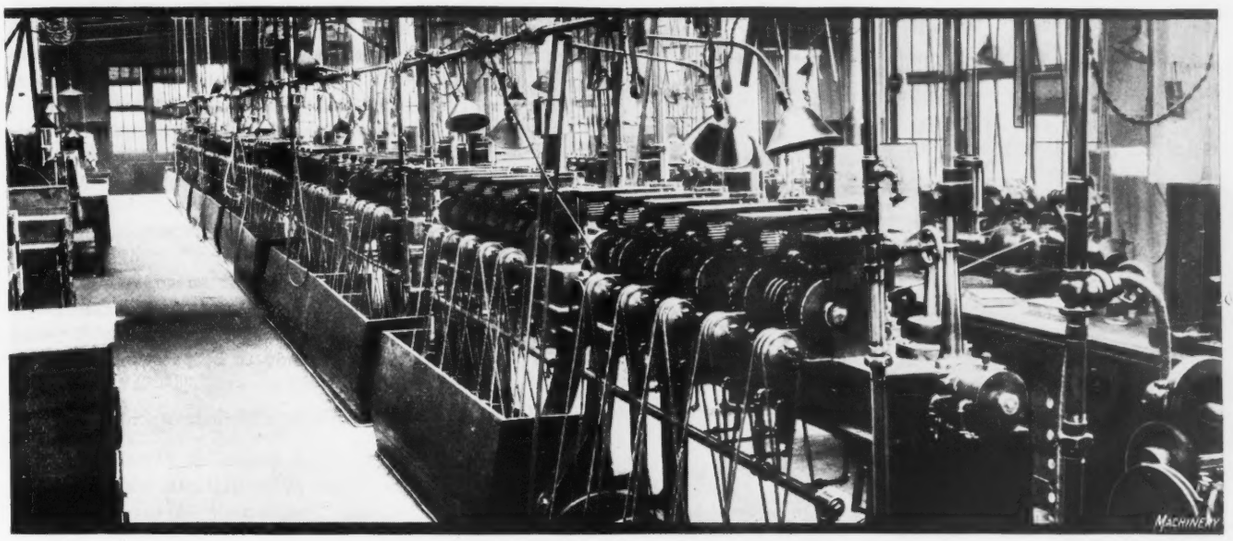
New Tariff Regulations

Early in July new tariff regulations were officially published. A general revision of the tariff rates will be made during the first three months of 1922, and the present rates quoted below are therefore only temporary. The rates published in the article entitled, "New French Tariff on Machine Tools" in June MACHINERY should be multiplied by the following coefficients: machine tools, 3.3; precision instruments, measuring instruments, and drawing instruments, 3; threading tools, turning, boring, and planing tools, and milling cutters, 3; vises, 4; drill chucks and drills, 4; wire-drawing dies, 4; files, 3.2; saws, 5; abrasives in pulverized form, 2.8; abrasive wheels, paper, and cloth, 2.7.

By employing coefficients that can be easily stated in this manner, an actual change in the figures designating the amount of the tariff in francs is avoided, the coefficient only being changed.

Labor Conditions

Although there has been no disturbances among the workers, the reductions in wage that have recently taken place in all the industries have not been accepted without protest. It is possible that the reductions have not been considered carefully enough in comparison with the actual reduction in the cost of living, and it is likely that with a return to normal industrial conditions some adjustments will have to be made again. The labor cost at the present moment is the principal production cost, amounting to a great deal more than the cost of materials. Hence, while six months ago the labor cost was one-sixth of the selling price, at present in many cases of manufactured metal goods, on account of decreases in prices, the labor cost has increased to one-third of the selling price. The Societe Alsacienne de Constructions Mecaniques at Grafenstaden, an important machine tool manufacturing concern, has closed its doors, as the men refused to accept a reduction of 20 per cent in wages; as a result, 2000 men are idle. In general, the principal metal-working concerns have reduced wages about ten per cent, in addition to the ten per cent reduction effected about three months ago.



Automatic Machines in a Watch Factory

Machines, Devices, and Methods Employed in the Plant of the Waltham Watch Co., Waltham, Mass.—Second of a Series of Articles

IN the first article in this series, published in August MACHINERY, automatic surfacing and drilling machines used in the manufacture of plates for watches were described, as well as a duplex type taper-turning and taper-boring machine. In the present article, additional types of automatic machines are illustrated and described.

Automatic Plate Recessing Machine

A seven-spindle automatic machine employed for producing the recesses in which the various watch wheels are set in pillar plates, barrel bridges, etc., is shown in Fig. 8. The work on which this machine is shown engaged is that of recessing barrel bridges. The shape of one of these parts may be seen at the end of the feed magazine *A*, and also at *B* in the assembly view of a watch, Fig. 1 of the first installment of this article. The eight carrier arms *B*, Fig. 8, are swung from left to right to position the work in the chucks, by an air-operated shaft which extends lengthwise beneath the machine, and which has rack teeth cut in it at intervals. The arms are oscillated by their gear connection to this rack shaft, the general construction being similar to that mentioned in August MACHINERY in the description of the plate roughing machine. Circular tools are used, which are mounted in tool-blocks supported on compound slides. The two slides *C* and *D* operate at right angles to each other, being actuated by levers *E* and *F*. Cams *G* control the lateral feed of the lower slide and the longitudinal or radial feed of the upper slide.

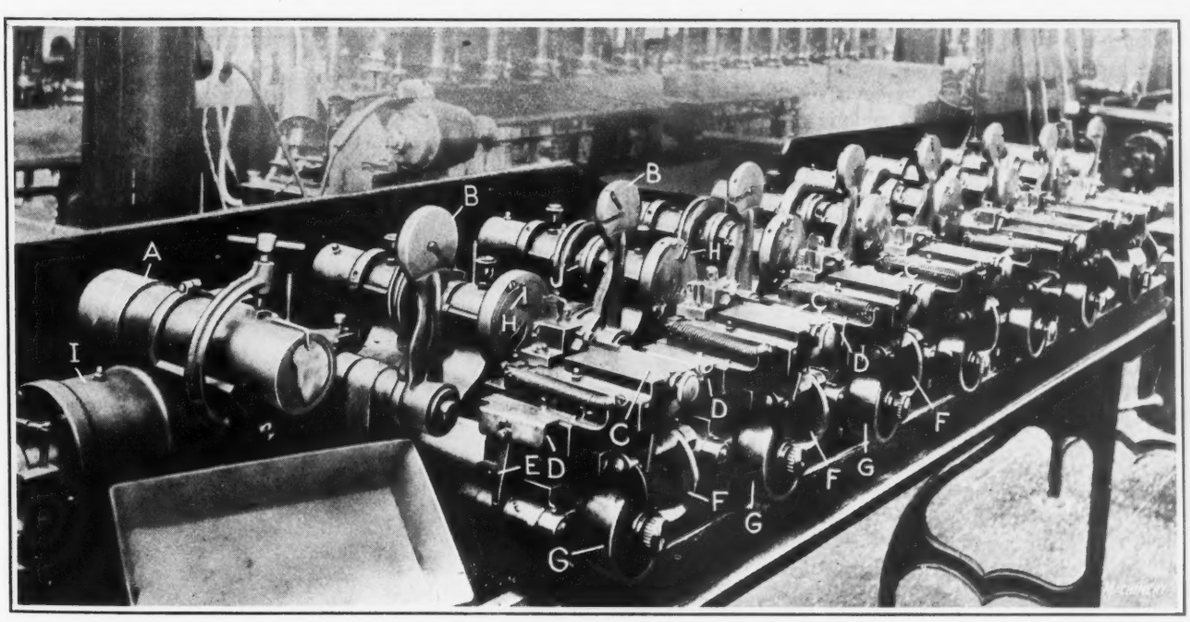


Fig. 8. Automatic Multiple-spindle Watch-plate Recessing Machine

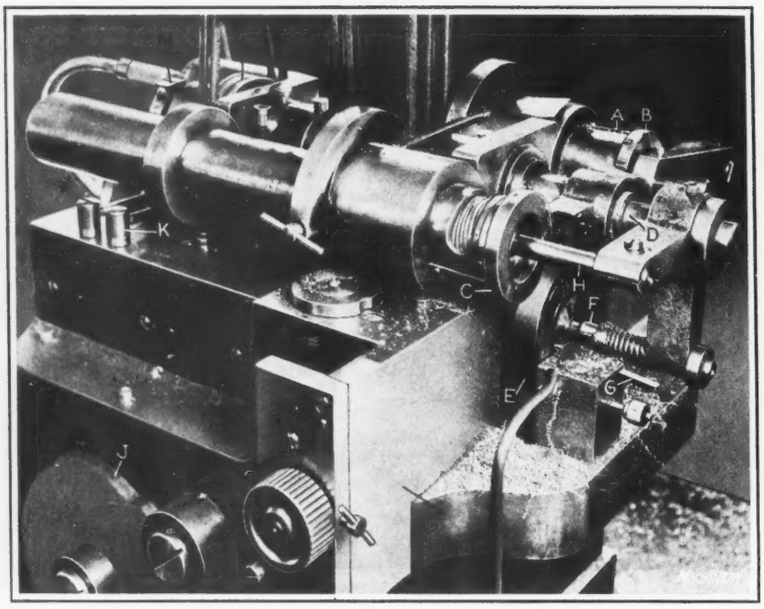


Fig. 9. Automatic Machine with Magazine Feed for turning the Rims of Watch Plates

When pillar plates are to be recessed, they are located in the chucks by dowel-pins, which engage the dial foot holes in the work. Incidentally, these three holes are used as a locating means in all operations performed on the pillar plates, if possible. The chuck is provided with spring jaws *H* for holding the barrel bridges, and obviously it is necessary to stop each spindle while being loaded from the carrier arms, in exactly the same position, so that the work will be located properly in the jaws. The abrupt stopping of rotation and the positioning of the spindles in the same angular relation to the work are accomplished by the operation of the air countershaft in conjunction with a one-tooth ratchet wheel and pawl. This ratchet wheel is located in front of the pulley and can be barely seen at *J*. As soon as the air which controls the direction of rotation is released and air is admitted to the opposite side of the countershaft pulley, the spindle is quickly stopped and reversed until the pawl which engages the ratchet tooth is dropped into place. The pawls are positively operated by the action of a cam.

The work passes from spindle to spindle for performing the various recessing operations, until it is finally delivered to the magazine at the opposite end of the machine. The work in the feed magazine is forced against spring jaws by air pressure, and these jaws are released by being forced radially outward when correspondingly located jaws on the carrier arms are brought into contact with them. The air then deposits the work into the carrier arm. After they have been swung into position in front of the spindles, the carrier arms are fed backward slightly, causing the hinged jaws *H* of the chucks to fulcrum and close over the periphery of the work and firmly clamp it in position.

The operations performed on a pillar plate are turning the recesses for the hour wheel and cannon pinion with tools mounted in the first tool-block; machining the interset-wheel cap recess and its clearance with one tool at the second station; cutting the minute wheel seat at the third station; producing the recess for the third wheel at the fourth station; turning the recess for the minute pinion at the fifth station; machining the clearance for the minute pinion recess at the sixth station; and cutting the dial recess at the seventh station. The air cylinder through which the shaft that operates the carrier arms extends is shown at *I*, and the shaft carries a suitable stop arrangement at the end for placing the arms in a neutral position, this being the vertical position in which the carrier arms are shown in the illustration. The carrier arms occupy this neutral position after they have received the work from the station at the left of each arm, and remain in readiness to swing to the right, this movement occurring immediately after an operation has been completed and the work is ready to be passed to the next station.

Plate Rim Turning Machine

The machine shown in Fig. 9 turns the recess in the pillar plate in which the dial is located. Magazine *A* at the rear of the machine feeds the work into holder *B* by air pressure from within, and after being located in the holder it is held securely by three spring jaws. This holder and holder *C* are carried by a double carrier arm which rotates on shaft *D* to bring the work into position in front of the centrifugal three-jaw chuck *E*, from which position it is forced into the chuck by the spring plunger *F*. The tool *G* is then fed in to the proper depth, and the slide on which the tool-block is mounted is fed in radially to complete the recess or cup-section for the dial. The work is next picked up by holder *C*, which has previously swung into position, and transferred to the magazine where the finished work is deposited. The plates are forced from holder *C* by pin *H*, which is moved axially with shaft *D*. Both the pin and the spring plunger are carried by a two-arm casting attached to this shaft. As soon as the shaft is reciprocated outward, the carrier arm is again in readiness to oscillate 90 degrees and bring another piece in holder *B* into alignment with the centrifugal chuck.

The 90-degree movement of the carrier arm is obtained by a four-notch ratchet wheel, these notches being successively engaged by a spring-operated pawl which is disengaged by an air-operated piston-rod. The ratchet wheel is attached to shaft *D*, which is belt-driven, so that as the pawl is disengaged and a 90-degree turn of the shaft occurs,

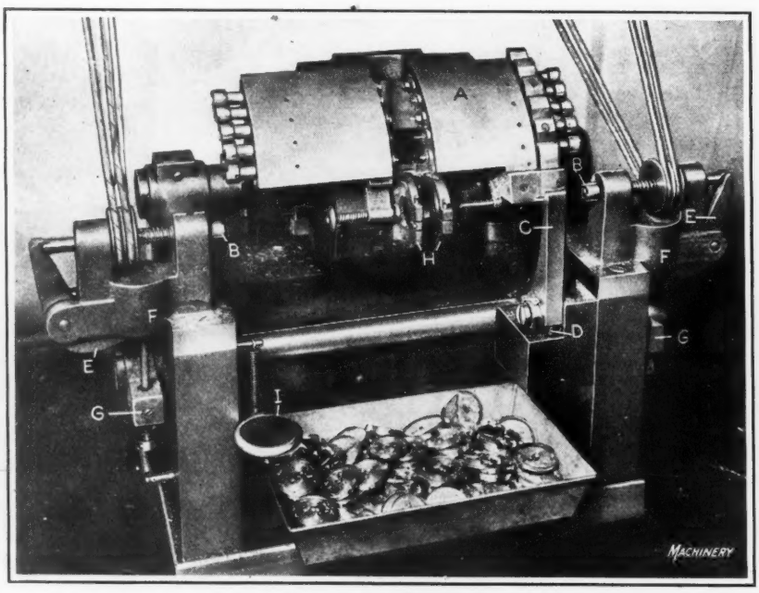


Fig. 10. Multiple Opposed-spindle Reboring or Uprighting Machine

the pawl will spring back into engagement and hold the shaft while the cut is being taken on the work. During this period the belt which drives the shaft and ratchet slips on pulleys *L*.

The cross-feed for the tool-slide *I* is actuated by cam *J* at the front of the machine, which controls the movement of a lever arm that transmits the motion to the slide. This lever has a ball-end which fits in a socket in the slide, allowing universal connection with the lever, which is required in producing the feed movement. The slide is returned to its normal position by the application of air. Shaft *D*, which slides but does not revolve, is guided at its rear end by a slotted finger *M* attached to it extending down with the slot riding over a square key. The knob shown at the front of the cross-slide is used to adjust the cross-wise position of the slide when setting up the machine.

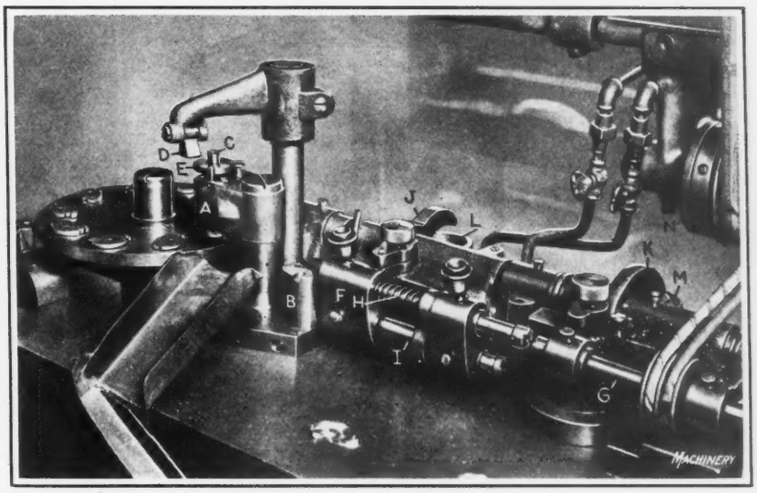


Fig. 11. Air-controlled Boring and Milling Machine for machining Clutch Clearance in Barrel Bridges

In some of the machines to be described, air tubes are provided of the type shown at *K*, for the direct application of compressed air to operative parts. In certain designs of machines it is often necessary to drill air channels through solid castings and direct the flow of air, in the manner most convenient, to the desired point. This method of utilizing compressed air in the operation of machines is novel and peculiar to those found in the Waltham Watch Co.'s factory, and it is this feature especially, rather than the cam-operated valve lever construction, to which attention is directed.

Uprighting Machine

The bench machine illustrated in Fig. 10 contains five pairs of opposed work-spindles which operate on opposite sides of the movement plates to bore the previously drilled holes in which the train wheel bearings are staked. This method insures that the holes will be absolutely normal with respect to each face of the plate. The spindles are carried in a swinging arm *A*, which is operated by a rack and pinion at the rear of the machine. This rack operates vertically by air pressure, swinging the spindle arm downward to bring the spindles successively into alignment with the driver at *B* at each end of the machine. The spindles are locked in the several operating positions by pawl *C* engaging with notches on the spindle arm. The pawl is operated by pin *D*, which is forced against the heel of the pawl by air pressure.

The driver spindles *B* are belted to an air-operated countershaft and are advanced axially to bring the clutch on each driver into successive engagement with the spindles, by means of a fulcrum lever *E* at each end of the machine. These two levers force the drivers forward when their lower ends are acted upon by air. The air cylinders are shown at *F*, and the application of air results in swinging the opposite ends of levers *G* into engagement with a feed-cam carried on the camshaft and located outside the frame at each end of the machine. The feed-cams, after each operation, permit the release of the driver clutch, this action being synchronized with the indexing movement of the spindle arm as it is swung downward by the rack-and-pinion construction previously mentioned.

The watch movement plates (which consist of the pillar plate with the various top plates assembled) are placed in a recess in one of the holders *H*, after which the two holders are brought together by air pressure and held in a vertical plane relative to the axis of the tools. After the various machining operations are completed, the work is ejected by a spring plunger shown to the left of one holder. This machine is semi-automatic, it being necessary after loading each piece by hand to depress the pedal *I* which engages a friction clutch connected with the driving gear on the camshaft of the machine. A quantity of these plates showing the number of holes that they contain may be seen in the foreground of the illustration.

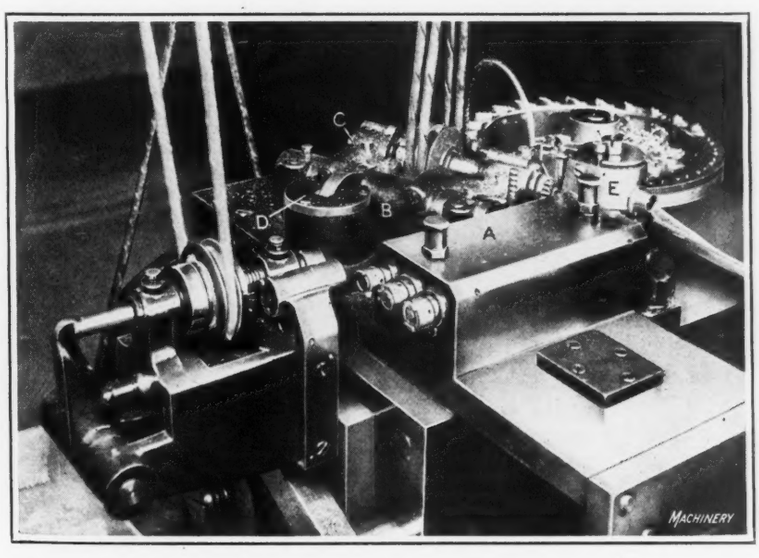


Fig. 12. Machine for centering, drilling, and tapping the Hole for the Hair-spring Stud in a Balance Cock

Dome Turning Machine

The operation performed on the machine illustrated in Fig. 13 consists of turning the diameter of the balance cock dome with an angular under-cut and boring a hole through the center, at a single setting. This insures concentricity between the hole and the turned circumference of the dome. The regulator arm is attached to this dome in the construction of a watch. This operation is performed after the plates have been assembled to the pillar plate, as shown at *A*. The assembled unit is located on the chuck *B* by spring jaws of the regular type, the location being such that a spacer bar *C* may be advanced to act as a support under the balance cock. This is a necessary provision because the unsupported end of the balance cock would not present a rigid enough surface to permit the operations to be performed with the required degree of accuracy. The air cylinder which operates this spacer bar is located at *D*.

The special feature of this machine is the means provided for readjusting the vertical height of the turning tool for each piece of work. An air-operated rack swings the spindle arm *E* to the right until spindle *F* is in alignment with the driver *G*. Spindle *F* is a locating spindle only, and is used for establishing the vertical height of the turning tool *H*. This setting is accomplished by feeding the driver *G* against the end of spindle *F*, which results in pushing the locating spindle down against the work and causing the yoke *I* to be raised or lowered slightly, in which new position the yoke spindle is locked in its bearing by an air-operated clamping device that binds a split collar *K* to the yoke shaft.

The feed mechanism is connected by a universal joint to the rear end of the fulcrum lever *J*, and as soon as the yoke shaft has been locked, the spindle arm is located in a new vertical position, from which the depth of cut employed in turning the dome is re-established. As soon as this height has been predetermined, the driver is raised and the spindle arm swung to bring the second or turning spindle into the operative position. At the completion of the turning operation, the spindle arm is again swung and the third or boring spindle is employed to machine the hole concentric with the turned dome.

The mechanism for actuating the feed is contained within the box casting which forms the base of the machine. It consists of an air plunger which actuates a bellcrank lever, bringing one end of the lever against the feed-cam; this air-actuated movement then permits the feed-cam to operate lever *J* and advance the cutting tools. This arrangement is known as a "permitted feed" movement. The tools are periodically set to the proper height in the carrier arm by a master gage of the disk type. This machine produces at the rate of 400 balance cocks per hour.

Balance Cock Drilling and Milling Machine

The automatic special-purpose machine shown in Fig. 12 centers, drills, and taps the hole for the hair-spring stud in balance cocks, and also mills a portion of the lug in which

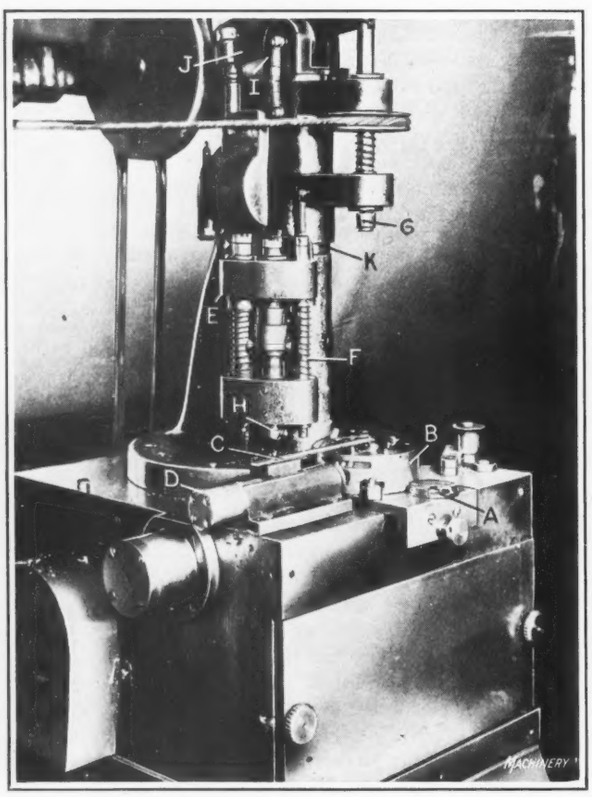


Fig. 13. Machine used for turning and boring the Dome on Balance Cocks

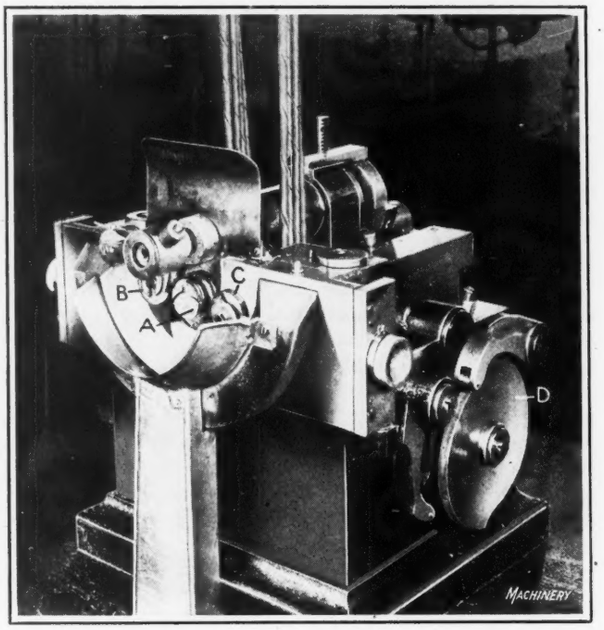


Fig. 14. Turning Plates to fit the Watch Case after assembling

this hole is machined. The balance cocks are located by pins on a turret which is revolved intermittently by a mechanism controlled by the work-carrier head *E*. This mechanism is contained within the machine frame and operates as soon as the spindles have finished working. The carrier spindle, as it revolves when another piece of work is to be picked up, trips a finger on the turret post within the machine, and this finger or lug carries a pawl which turns the turret by engaging a ratchet wheel also mounted on the turret stud. The work is picked up and swung into position and held thus during the several operations. The opening and closing of the jaw which is on the under side of the carrier head, is accomplished by a small pin extending vertically through the head, which is operated to contact with the end of the jaw by an air plunger actuated by a cam within the machine. When the work is being picked up, this plunger is depressed. A similar carrier head is illustrated at *A*, Fig. 11.

The three spindles of the machine are clutch-driven, and provided with a "permitted feed," the general construction being similar to that already described in connection with other machines in this series of articles. The feed-cam in this particular instance, however, has been designed to furnish a relief motion for the drill, but in other respects the mechanism is not radically different from the others. The tools, which project from the further end of the spindle-block *A*, are provided with three stop-pins for limiting the depth of cut, and when the slide moves crosswise to bring each spindle in alignment with the driver, an arm on the frame of the machine, is swung over to act as a locating abutment for these stops.

The rear end of the cross-slide carries the swinging bracket *B* in which the milling spindle *C* has its bearing. This spindle is belt-driven and has a "permitted" radial feed movement which functions as follows: As soon as the three spindles have completed their work and the slide has advanced the milling cutter *F* into position for taking its cut, the projecting end of a lever attached to the camshaft of the machine is forced up by cam action and raises a stop-pin until it bears on the under side of bracket *B*, and acts as a steadier for the cutter during its downward feeding movement. The air cylinder *D* then causes the bracket to swing downward, thus feeding the cutter through the work.

A device for automatically stopping the machine if breakage of the drill or tap occurs is included in this machine

equipment, and is located at the further end of the machine. There is a contactor, or piece of flat steel, against which the tools bear one at a time as the slide is fed forward to the next operative position. As long as contact exists between the tool which has just finished operating and the contactor, a steel magnet at the opposite end of the machine will act on the free end of a flat finger which is regularly reciprocated under it by cam action. As long as the tools continue to contact, the magnet will draw this lever up and over the trip which operates the air valve for shutting off the air to the countershaft. If the tools fail to contact, however, there will be no magnetism in the steel piece and the reciprocating finger will be permitted to trip the air valve and immediately stop the machine. The cam that reciprocates this flat finger is attached to the end of the regular camshaft of the machine.

Boring and Milling Machine for Clutch Clearance on Barrel Bridges

A machine for milling the winding pinion clearance and for boring the clutch clearance on barrel bridges is illustrated in Fig. 11. The work is loaded and located by pins on the turret of the machine. The work-carrier head *A* is swung from the position in which it is shown, to the right, until it is in a position to locate the work on block *B*. This movement is accomplished through the medium of an air cylinder on the left-hand end of the machine having a plunger on which teeth are cut to engage a segment gear and operate the take-up and retainer pawls. The work is picked up and held by the jaws in the carrier head, and is deposited on block *B* and held in this position until the machining of the work has been finished. The carrier head, with the work, then swings backward to the left, and when it reaches its foremost position a step on the vertical stud *C* is depressed by the swinging triangular trip *D*, past which the stud cannot travel without being depressed. Depressing this stud causes the collar *E* to force down the pivoted jaws by means of which the work is held on the under side of the head, opening them and allowing the work to drop into a chute.

The spindle arm *F* carries two spindles, one for each operation, and these are driven by a clutch on the driver *G*. A "permitted" cam-feed motion is incorporated in this machine, the construction of which has previously been described. This spindle arm may be held stationary as required in the boring operation, or may be fed both independently of the driver when indexing the tools and with the driver when performing the milling operation. This is the special feature of this machine to which attention is directed.

The boring spindle is shown at *H*, and after the hole has been bored, arm *F* is swung upward by a combined cam and compressed-air movement, and the driver clutch brought into engagement with the milling spindle *I*. In this position finger *J* has swung downward into contact with the end of the air-cylinder piston; also finger *K* at this part of the movement is in contact with the piston of another air cylinder. The pistons in these two air cylinders *L* and *M* are operated in unison during the milling operation, and permit both the milling spindle and the driver to feed upward a distance of about $\frac{3}{8}$ inch, which is the required amount for producing the clutch clearance on the work.

The spindle arm is returned to the position shown in the illustration by means of a spring, after which the work is picked up and deposited in a chute as previously described. The machine is driven from a worm and worm-wheel, by means of a camshaft which extends through the machine and carries the cams for operating the various air valves and the feed-cam for the spindles. The air countershaft is shown at *N*.

Plate Diameter Turning Machine

After the barrel bridge, pillar plate, and balance cock have been assembled to the pillar plate as shown at *A*, Fig. 14, the diameters of the assembled unit are turned on the bench machine shown in this illustration. Circular tools *B* and *C*, mounted on each side of the work-holding chuck, are employed, the slide on which these tools are mounted being reciprocated to bring the tools alternately into operation. There are four diameters turned with the two tools shown, and the feed movement is "permitted" by the use of compressed air, and is actuated by the cam *D* shown at the right-hand end of the machine. Provision is also made, by the application of springs and compressed air, for moving the work-holding chuck transversely so that the same tools may be used to turn two other diameters.

The third installment of this series of articles will be published in October MACHINERY, and will contain a description of an automatic watch pinion making machine, a wheel opening or reboring machine, and automatic machines for cutting teeth in steel wheels and for numbering watch plates, concluding with a description of the process and machine used for finishing the convex heads of watch screws.

* * *

METAL FATIGUE UNDER REPEATED STRESSES

The development of the internal combustion engine, the steam turbine, the automobile, and the airplane has made the study of the fatigue of metals of increasing importance. Much information relating to this subject was given in a paper by H. F. Moore and J. B. Kommers, recently read before the American Iron and Steel Institute. The failure of machine parts under repeated stress has come to be commonly spoken of as due to "fatigue" of the metal. The cause of such failure was at one time thought to be the "crystallization" of the metal. In the paper referred to, it is shown that the phenomenon is one of a breaking up of crystals rather than of their formation.

RESULTS OF STRESS TESTS

Part of Structure or Machine	Approx. No. of Repetitions of Stress in the Life of the Structure or Machine
Railroad bridge, chord members	2,000,000
Elevated railroad structure, floor beams	40,000,000
Railroad rail, locomotive wheel loads	500,000
Railroad rail, car-wheel loads	15,000,000
Airplane engine crankshaft	18,000,000
Car axles	50,000,000
Automobile engine crankshaft	120,000,000
Lineshafting in shops	360,000,000
Steam engine, piston-rods, connecting-rods and crankshafts	1,000,000,000
Steam turbine shafts, bending stresses	15,000,000,000
Steam turbine blades	250,000,000,000

Machinery

The accompanying table, which gives some idea of the number of repetitions of stress in the normal life of various structural and machine members, was prepared from the data supplied in the paper referred to.

* * *

According to a recent Commerce Report, there was a total of sixty-seven foreign steamship lines maintaining regular routes from Hamburg, Germany, to the principal countries of the world, at the beginning of 1921. Among this number were represented several flags which seldom, if ever, had been seen in that port before the war. The nationalities represented, together with the number of lines of each, were as follows: English, 22; Dutch, 11; Norwegian, 6; French, 5; Belgian, 4; Italian, 3; Swedish, 3; American, 2; Danish, 2; and Japanese, 2. The remaining seven lines were of various nationalities.

Group of Brown & Sharpe Employes, consisting of Twelve Nationalities, being assisted in filling out Citizenship Papers

Industrial Americanization

Policy of the Brown & Sharpe Mfg. Co. in Assisting Alien Employes to Become American Citizens

By LUTHER D. BURLINGAME, Industrial Superintendent, Brown & Sharpe Mfg. Co., Providence, R. I.

WHILE Americanization work among the children through the public schools must be looked to as the most important means of assimilating the many peoples of as many ideals who come to our shores, it is believed that the adults in our industries must not be neglected, either in the matter of language, customs, or in the ideals of American institutions and government, if we are to reap the benefits and avoid the dangers resulting from promiscuous immigration. Various methods have been tried to reach and influence adults coming from foreign countries, but with only partial success, and in many cases with admitted failure. Even though free opportunities for instruction and guidance are offered and the way is made easy, it is the exception rather than the rule for such adults to take advantage of the opportunities that are offered, and it requires watchfulness and sometimes drastic action to keep their children in school until they reach the minimum age limit.

To stimulate an interest in school attendance on the part of adult aliens, various methods have been tried, among which are the offering of prizes, paying wages during the time of instruction, or imposing penalties in the way of discharge or lack of opportunity for advancement for those who would not accept the help offered. Even such inducements or penalties have often proved futile. There is a general feeling among those who have dealt with this question that Americans made under compulsion, or by the holding out of what may be classed as bribes, are at best poor Americans, and that while figures may thus be made to show much progress in Americanization the results are but skin deep and of little real value.

In one of his last public addresses Theodore Roosevelt urged strongly that only such immigrants should be allowed to enter this country as would agree to learn the English language and acquaint themselves with American ideals, that ample provision be made at public expense to give them the needed instruction, and that, if after a reasonable time they had not complied with the conditions, they be sent back to the country from which they came.

In the industries lies the greatest opportunity for doing effective Americanization work. Here the foreign-born come in contact with American workmen, and are given an opportunity to absorb American ideals. From their associates and those under whom they work they derive their ideas of what this country stands for, and whether they become loyal or otherwise depends largely upon their industrial environment. If the managements of industrial plants encourage steps toward Americanization in a manner that will promote a feeling that the service is given as a privilege and opportunity, rather than as compulsion, much can be done of a helpful nature along these lines.

Responsibility of the Industries for Americanization Work

It is in the industries where there is the greatest opportunity to deal helpfully with adult foreigners in Americanization work. Here they come in contact with American workmen and the use of the English language, and are thus given an opportunity to absorb American ideals. From their associates and foremen they derive their ideas of what this country stands for, and whether they become loyal or otherwise

depends largely upon their industrial environment. If the managements of industrial plants encourage steps toward Americanization, and cooperate with the workmen in taking out citizenship papers, and in becoming proficient in English, etc., and if this is done so that the men will feel that the service is given as a privilege and opportunity rather than as compulsion, much can be done of a helpful nature.

To carry out such a program, it should be understood throughout the works that the officials of the company are behind the movement—that they consider it important and are undertaking it seriously. In the language of commercial men, they must "sell" the idea to the foremen, who, in turn, must be so instructed and enthused as to "sell" it to the men. The preliminary canvass of a plant to learn the facts regarding citizenship is likely to bring out some matters of surprise as to who are and who are not American citizens. Foremen and others in responsible positions, in some cases, are not citizens themselves. There will also be found a surprising lack of knowledge on the part of foremen as to the status of their men relative to nationality and citizenship.

Americanization Methods in a Machine Tool Works

In the winter of 1916-1917, the officials of the Brown & Sharpe Mfg. Co. were impressed with the importance of Americanization work, not only from the standpoint of developing an interest among alien employes in becoming citizens and of training them in the English language and American ideals, but also in order to know who might be trusted as being loyal and who might need watching when America entered the war, which then seemed inevitable. The campaign was inaugurated by giving a dinner to the foremen at the local Y. M. C. A. building. The foremen were invited by formal letters signed by the secretary of the company, so that in every way it was impressed upon them that the matter was important and that their cooperation was expected. The officials of the company sat at the head table with national representatives of Americanization work, and the situation was forcibly presented, both from the standpoint of the national movement and from the point of view of the company. The industrial secretary of the Y. M. C. A. was requisitioned to give active help in cooperation with shop officials in carrying on the campaign.

TABLE 1. PROPORTION OF NATIONALITIES APPLYING FOR CITIZENSHIP IN THE B. & S. PLANT FROM 1916 TO APRIL, 1921

Nationality	Number Becoming Citizens	Number Securing First Papers	Total
English	272	178	450
Scotch	72	82	154
Irish	111	165	276
Canadian	95	90	185
British West Indian	3	2	5
Total English-speaking races	553	517	1070
Swedish	117	97	214
Italian	99	240	339
Armenian	11	84	95
Polish	10	72	82
Russian	26	98	124
Turkish	3	4	7
French	5	3	8
Norwegian	5	5	10
Portuguese	4	13	17
Dutch	3	4	7
Austrian	4	13	17
Bulgarian	0	2	2
Lithuanian	5	6	11
German	7	5	12
Danish West Indian	3	0	3
Danish	2	0	2
Swiss	2	6	8
Bohemian	2	2	4
Total non-English-speaking races	308	654	962
Grand Total	861	1171	2032

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TABLE 2. RECORD OF B. & S. EMPLOYES IN THE EVENING CLASSES

	Classes in English			
	First Term	Second Term	Average	Prizes
No. Enrolled	112	67	90	$461.38
No. Completing	69	39	54	$227.46

	Classes in Citizenship		
	First Term	Second Term	Average
No. Enrolled	24	10	17
No. Completing	13	2	8

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Following this meeting, a census of the factory was taken, through the foremen and clerks of departments, and an index made. Each card contained the name of an alien and stated whether or not he had been in the country and state a sufficient length of time to make application for first naturalization papers. If he had previously made an application a record was made of the date on which this had been done. A record was also made of those who had made application for second papers and were waiting for appearance in court, dates and other needed information being noted.

A notice was then sent to each man eligible for citizenship or for advancement in his steps toward citizenship, calling his attention to the fact, asking whether he desired to become an American citizen, and offering him help if desired. The majority replied "Yes," and for all such an appointment was made to meet a representative of the company during working hours, and be given assistance in making out his papers. The accompanying illustration shows a group of men of twelve different nationalities being helped in this work. About fifteen minutes time was required for each employe, and a special job number was issued to which this time was charged. The applicant was then directed to go to the Federal authorities, pay one dollar, and complete his application. Upon receipt of word from the Federal authorities that a man had done so, his card was filed in a "tickler" index dated two years later, showing the time at which he should make application for second papers. All cases pending, including those waiting for second papers, were filed in a similar manner and as the period was reached when they should take the next step, they were notified and the offer of help repeated.

Results Secured by the Method

Those declining citizenship were further interviewed by their foremen, and some induced to change their minds, but no pressure was brought to bear at the time if a man refused. The reason most often given by a workman for not becoming an American citizen was his intention of returning to his native country. There were also many who felt that while their native country was in the war, and America was not, it would indicate cowardice to renounce their allegiance to their mother country. Many of these took out their first papers as soon as the United States entered the war. One man refused to apply unless the company would pay the dollar fee.

In the first comprehensive campaign, the 1312 aliens then employed in a total force of about 6000 were all interviewed relative to citizenship, and all but 201 took steps toward citizenship for which they were eligible at the time. Many already had first papers and, the two-year waiting period having been passed, were eligible to become citizens at once.

Others having first papers were waiting for the expiration of the time limit so that they could apply for second papers. Over five hundred applied for first papers.

Classes in English and Citizenship

Following the first general canvass, language classes were started which were held during the noon hour, those in English being of two grades, the first for those who had little knowledge of the English language or were illiterate in any language, and the second for those who were more advanced. These were carried on under the Roberts system. Lessons were also prepared under such headings as "Getting a Job in the Foundry," "At Work in the Foundry," "At Work in the Paint Shop," etc., these being in the form of simple dialogues printed in English and in each language represented by a sufficient number of workmen. Evening classes in citizenship were being conducted in the city in which the plant is located and many employes took advantage of these. Literature was distributed to men preparing for citizenship, including the Constitution of the United States and leaflets telling of the requirements of citizenship, of our form of Government, and of some of the important historical events which should make a man proud to be a citizen of this country.

Statistics of Americanization Work

During the last four years about 2600 employes have been approached regarding citizenship. Of these, 2032 have made application and the company has a record of 861 having become full citizens. No doubt hundreds of others who made application through the cooperation of the company have completed their citizenship, but having left its employ there is no record available. Table 1 shows the number of men who applied for citizenship and the proportion of nationalities. It will be seen that more than half of those who applied were recruited from the English-speaking races, while a still greater proportion of those who have become full citizens are of those races. Of those still employed there are now 184 waiting for the time limit to complete their citizenship, and a recent report from the foremen shows 66 recent employes not as yet citizens who have not been reached but who will be in the near future. Adding to these a few of the old list who declined to become citizens because of being illiterate or too old to feel it worth while, gives a total of only 263 of the entire force not as yet full citizens, and most of these will become such within the next few months.

In the recent reduction of the force due to the depression of business, the policy was to lay off alien employes rather than American citizens, other things being equal, and in rehiring, this thought of giving preference to American citizens, whether native or by adoption, will be kept fully in mind, the employment department being especially watchful not to give preference to men who showed a disposition to be "slackers" and evade their evident duty when their native country or the land of their adoption was at war.

Aid of Public Schools in Americanization

During the winter of 1919-1920 a special effort was made in Providence to stimulate an interest among adult aliens in the study of English and in preparing for citizenship. Evening classes with competent teachers were provided in eight of the public schools, and classes in citizenship were also held at the public library. The industries of the city were asked to assist in arousing interest and securing attendance. The earlier efforts of the Brown & Sharpe Mfg. Co. to encourage attendance at noon-time classes had been but partially successful, it having been necessary to bring pressure to bear through foremen, and in various other ways to secure continued attendance. Therefore, in cooperating with the public schools, it was thought best to offer an inducement to a man to attend the English classes, even though it was believed that a desire to better himself by learning to speak and write English and by becoming an American citizen should be a sufficient inducement without holding out any further reward.

At that time a large proportion of the employes were members of thrift clubs and purchased thrift and war savings stamps in large quantities weekly. For this reason it was decided that the inducement offered should be prizes of thrift and war savings stamps. A thrift stamp was given for each session attended, provided a favorable report was received from the teacher as to faithfulness in attendance and in doing the required work at the school. This small inducement appealed to the men so strongly that the attendance jumped at once to a point much higher than had before been reached, and was so large as to cost the company during that winter nearly $700 in prizes. The gathering of these "coming Americans" to receive the prizes was an inspiring occasion. The meeting was addressed by the superintendent of schools and by officials of the company. To look into the faces of these men and see their interest, intelligence, and responsiveness, gave a feeling that they were assets to the nation, and that it is not always necessary to wait for the second generation in order to secure desirable citizens.

Of course, when the novelty of school attendance had worn off, excuses for absence and for dropping out gradually increased. Some of these are interesting, such as "going to see my girl," "sickness at home," and "too hard to learn." The record for the winter's attendance in English classes, distributed among eight of the city schools, is shown in Table 2. The attendance, it will be seen, fell off during the second term, but it is interesting to note that in each term about the same percentage (60 per cent of those starting) completed the course. In the citizenship classes no prizes were offered, and as a result, the enrollment was much less and the dropping off more noticeable. These statistics are also given in Table 2. It is no more than fair to state, however, that in the citizenship classes the small number in attendance at some of the schools led to abandoning the classes, so that those who would have willingly continued were forced to drop out. In both the English and citizenship classes some of the falling off was due to an increased amount of night work at the plant.

Summary

The loyalty of the force during the war, as shown by the large number of alien employes (133) who went into the service, largely in the United States Army and Navy, and the response of those remaining at the works to calls for financial help and other imperative demands of the war, can be traced, in part at least, to the influence of the previous Americanization work. Because of the situation created by the war, the activities here described to assist "coming Americans" would be fully warranted as an aid to America in the war, and its aftermath, yet this is but a small proportion of the benefits resulting—benefits belonging to times of peace—and a policy of undertaking such work can be recommended to all employers of alien labor.

Judging from past experience and the showing in other industrial plants, it is believed that an active citizenship campaign is needed to bring results, because but a small percentage of aliens will become citizens on their own initiative. Even those who go so far as to take out first papers often fail to take further steps—in fact, many were found whose first papers had become outlawed because of exceeding the seven years' period allowed, thus requiring these men to take out their first papers again and go through an added waiting period. While the war served as a special reason for carrying on an active campaign, the making of citizens permanently interested in and feeling that they are a part of our body politic is what will give lasting results. Such results can be obtained only by interest and enthusiasm on the part of the employer, coupled with systematic, sustained, detail work.

Design and Making of Drop-forging Dies

Methods Employed in Modern Drop-forging Plants—Second of Two Articles

IN the first article dealing with the design and making of drop-forging dies, published in August MACHINERY, all the factors entering into the design of drop-forging dies were discussed, including die materials; the proper grade of die steel, and the considerations entering into its selection; the importance of adequate draft, shrinkage, and machining allowances; the laying out of the die impressions; and the design and purpose of the fuller and the edger. In this article the actual making of the dies is discussed.

Sinking the Die Impression

Having selected the steel for the dies, according to the size and requirements of their service, and determined upon the location of the impression and the location and design of the fuller and edger, the next step is to follow out the machining operations in making these impressions. Two practices are followed in sinking the die impression, which may be broadly classified as all-mechanical and part-mechanical methods. In both of these methods, the machined surfaces must be finished by the usual hand work, although in the all-mechanical method the amount of hand work is greatly reduced. In general, the machines and methods used are those which can be most conveniently employed.

In Fig. 6 is shown a No. 6 Becker milling machine and the roughing mill employed in hogging out the fuller impression in a locomotive switch crank die. This die illustrates a case where, on account of the depth of edger *A*, the matching surface must be on the left-hand and the edger on the right-hand side, just opposite to the usual design. It has been stated that no matter how the die impression is produced, a certain amount of hand work, such as typing and riffling, is required and that the development of modern automatic machines has reduced the amount of hand work materially. For convenience in differentiating between the practices followed in sinking a drop-forging die impression, that method in which automatic machines of special design are employed has been termed "all-mechanical," although this expression is not literally correct, as considerable hand work is sometimes necessary on intricate designs, even when automatic machines are used.

Die-sinking Machines

One of these die-sinking machines is made by the Jackson Machine Tool Co., of Jackson, Mich., and is essentially a vertical milling machine provided with an additional head for cutting semi-cylindrical impressions, such as those by means of which a camshaft is drop-forged. The second head is commonly called a cherrying head, and carries a cherrying tool which is semicircular in shape and which has an oscillatory movement imparted to it through the mechanism of the head. On the completion of the cutting stroke of this oscillation of the tool, the tool is lifted from the cut and again lowered into the impression at the termination of the return stroke. Since the table of the machine is fed under the cherrying tool, it will be readily seen that a semi-cylindrical groove of varying length and radius can be readily machined. By employing tools of narrow width, it is possible to machine comparatively deep circular impressions to such a degree of accuracy that little, if any, typing is required. It is not probable, however, that the use of types for the more intricate cavities will ever be supplanted by this method.

An entirely different type of automatic die-sinking machine is manufactured by the Keller Mechanical Engraving Co., Brooklyn, N. Y. The principle employed in the design of machines of this company's manufacture is that incorporated in profiling machines. Instead of following an outline, however, a master pattern or model is employed which may be cast from an ordinary wood pattern or from a plaster-of-paris mold, or it may be built up from laminations corresponding to various sections of the forging and then machined. One of these machines is known as a duplicating type, and in this design the die produced is of the same size and shape as the pattern used. The work is

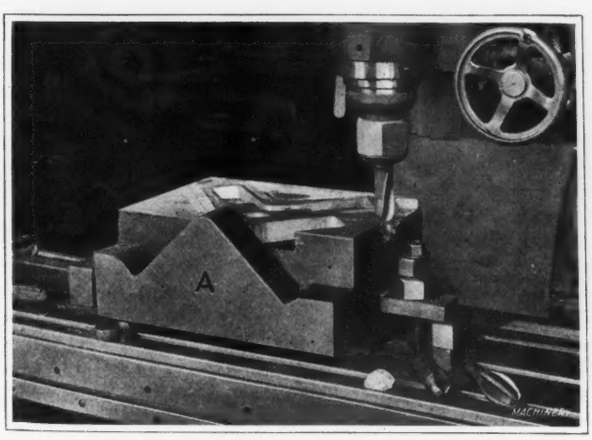

Fig. 6. Machining Impression in Locomotive Switch Crank Die

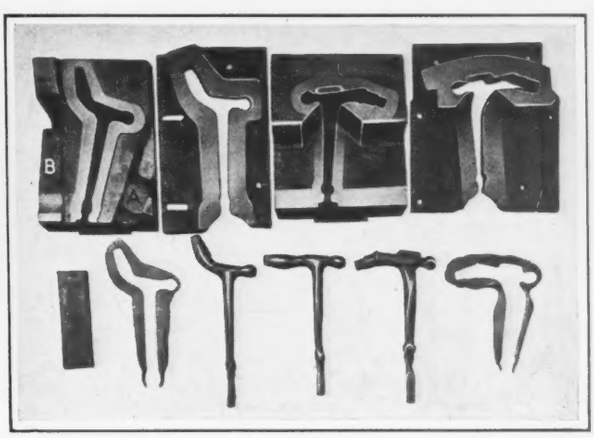

Fig. 7. Forging and Trimming Dies for Automobile Steering Arm

located directly in the machine without the necessity of laying out the impression, with the face of the die in a vertical plane. A rotating cutter carried on the lower part of a swinging frame is employed to remove the metal. The upper part of the swinging frame carries a tracer, which passes over the contour of the master model as the table on which the pattern is mounted traverses back and forth and feeds upward, thus guiding the outline machined by the revolving cutter. Means are provided for keeping the tracer point in contact with the contour of the master, and where particularly intricate dies are to be reproduced the chaser point is also revolved to facilitate following the rise and fall in the impression. The frame on which the revolving cutter and the tracer are carried is mounted on centers in such a way that it will swing freely outward and at the same time keep the tools in contact with the impression by the application of a suitably located counterweight.

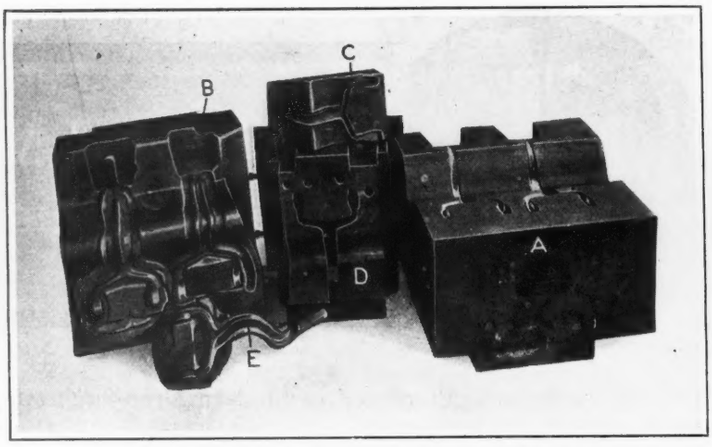

Fig. 9. Drop-forging Dies for Motor Truck Towing Hook

The reducing machine for die-sinking, which is also manufactured by the Keller Mechanical Engraving Co., employs the same method of establishing the contour of the impression, namely, a master model. With this machine, however, a different construction is employed owing to the fact that a larger pattern is used. It is stated that die impressions of an intricate nature can be more accurately reproduced when the master is larger than the die impression. Obviously this facilitates the manufacture of the master, and enables the delicately proportioned parts of the impression to be more accurately reproduced.

In this machine, two vertically revolving faceplates are employed, on one of which is attached the master, and on the other the die-block in which the impression is to be sunk. The tracer point (which may revolve or not as required) and the revolving cutting tool are adjustably mounted on a pivoted bar. This bar is so hung that it may swing freely in either a horizontal or vertical plane as the tracer passes over the master pattern. The relative distances of the two faceplates and the centers of the tracer and the tool from the end of the swinging rod on which these tools are carried establishes the amount of reduction. It will be obvious that in case the positions of the work and the master are reversed, an enlargement rather than a reduction will result, but for the manufacture of drop-forging dies such a setting of the machine would hardly be of advantage. In both of the machines which operate on the master model principle, the feed of the cutter and tracer is from the center of the pattern to the periphery, and suitable feed and speed changes are provided to correspond with the size of the work being machined. Machines of these types employ round-nosed cutters, ordinary end-mills, and in some cases cutters of special though simple design. Three cuts are often required, the end-mill being used to rough out most of the metal, and the intermediate and finishing cuts being taken with special milling cutters. The cherrying machine and the automatic profiling or duplicating machine are shown in the heading illustration.

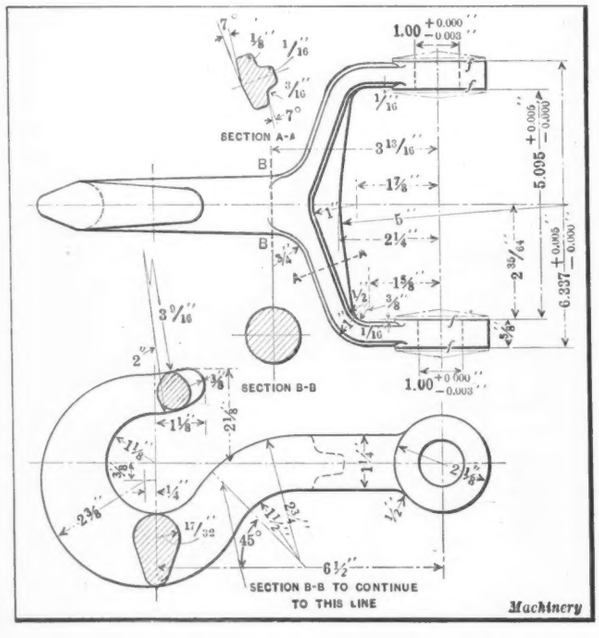

Fig. 8. Towing Hook, drop-forged in Dies shown in Fig. 9

Two-impression Dies

A second or finishing die is often required, as in the case illustrated in Fig. 7, because of an offset or bend in the forging. The automobile steering arm which is produced in the dies illustrated has a sharp offset, necessitating much more work in sinking the impression than would otherwise be required. Dies of this kind are known as locked dies, and in designing them there must be sufficient flat striking surface to absorb some of the shock produced by the hammer blows. This is a case where the all-mechanical method of die-sinking will result in a great saving of time and money. When the impression is to be laid out, it is apparent that a templet cannot be used owing to the offset. In such cases use may be made of a lead casting made from half of the first-impression die; this is bent to the proper offset, laid upon the face of the blocks which have previously been machined to the contour of the parting line of the forging, and circumscribed with a scratch awl.

Nearly every design of forging may be considered as a special case. It would therefore be impossible to attempt to cover all points in design except those that are most commonly encountered. Often the piece is of such shape and size that the first and finishing impressions can be made in one block, so that the forging will not require a second heating to complete it. In drop-forging eye-hooks in which the eye passes through the forging at right angles to the bend in the hook, this method can be employed. By producing a large lump of metal in the first-impression die, when the eye is subsequently to be forged, and then transferring it quickly from one impression to the other and turning it at right angles, the end through which the eye passes can be drop-forged while the part is still hot.

Another example where a two-impression die is employed to drop-forge a hook is shown in Fig. 9. These dies are used in the production of the motor truck towing hook shown in Fig. 8. The upper die is shown at *A* with the impressions partly completed, the lower member at *B*, and the trimming punch and die at *C* and *D*, respectively. The forging produced in the finishing die is shown lying in the impression, and the forging produced in the breakdown die at *E*. It will be noticed that a large amount of flash is produced in making the drop-forging, which must be trimmed off before

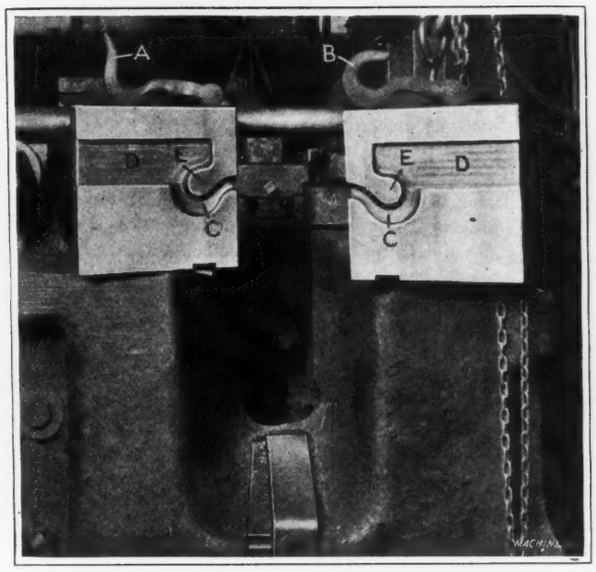

Fig. 10. Upsetter and Dies for bending Towing Hook

the end of the hook can be bent. This bending is a job for the upsetter or forging machine, and Fig. 10 shows the hook with the flash removed; the illustration shows the hook at *A* and *B*, before and after bending, respectively, resting on the upsetter dies by means of which the bend is produced. This is a view looking into the end of the machine. The end to be bent is held in the impressions *C*, with the tapered end in a vertical position, so that the bender which slides in channels *D*, may force the end of the hook around the center *E*. These dies are of comparatively simple design, and the method of making will not be gone into, as they cannot really be classified as drop-forging dies, although closely identified with the production of drop-forgings.

The method of making dies for drop-forging bronze, copper, and aluminum is not different from that already described. In finishing the impressions, however, much more care must be taken to produce a surface which will be free from all imperfections and tool marks. If this is not done, the forgings will be unsatisfactory and will cause difficulty in handling in the dies. Carbon steel die-blocks will be found suitable for this class of forgings.

Trimming Punches and Dies

In most cases the lead casting is employed in laying out the hot trimming dies, but for the cold trimming dies a forging is usually obtained and used as a guide in finishing the die opening. Two hot trimming dies are shown in Fig. 7, one for trimming the first-operation forging and one for the finishing operation. The die openings are cut in a plate which is attached to a bolster plate, designed so that as the punch descends, the hot forging may be pushed through and withdrawn from an opening under the die plate. In the case of trimming dies for cold work, the design is practically the same as that used for hot trimming dies, except that in hot-trimming the sprue is usually removed in a subsequent operation, while in cold work the entire scrap is removed at once. It will be evident that the openings at the front of the trimmers shown in Fig. 7 are for the passage of the sprues.

The steel for hot trimmers may be considerably lower in carbon than for cold trimmers. For cold-trimming, shear must be provided on the cutting edge of the die. For long, comparatively large work, and especially if the forging is of circular or of irregular section, this shear may be similar to a scallop. In such a case the shear should be located between the ends of the die opening. The punch should be formed on the face to conform with the shape of the forging, so that it will bear firmly on the ends and prevent the forging from being displaced when the press descends and forces it through the die. The punch and trimming die shown in Fig. 9 are good examples of tools of this kind. These are used for hot-trimming, the punch *C* carrying the form of the forging on its face, and being shaped to agree with the hook.

Shear for Trimming Dies

For flat work the cold trimmer should have shear provided from end to end of the die opening, but not enough to cause the forging to tip up at one end. The degree of inclination, or shear, commonly provided for cold trimmers is frequently expressed as a fraction of the thickness of the flash being trimmed; for example, one-half shear means that the inclination of the die face is equal to one-half the thickness of the metal to be trimmed. The shear may also be expressed as inclination of the face of the die in inches per foot, which is the more common method when referring to trimming dies. It does not matter whether the die has a straight shear or whether it has several cutting edges as in a scalloped shear, as regards the pressure required to trim the forging. The pressure, in pounds, required to force a forging through a trimming die provided with shear, when this amount is expressed as a fraction of the flash thickness, may be determined by the following formula:

$$W = \frac{ldf}{c}\left(t - \frac{dt}{2}\right)$$

When the shear is expressed in inches per foot of inclination, the following formula applies:

$$W = \frac{6dt^2f(2-d)}{S}$$

in which W = pressure in pounds required to force forging through die opening;
l = length of cut (or distance around the die opening) in inches;
d = a constant varying from ¼ to ½—usually taken as 1/3 for cold steels;
f = ultimate strength of material, in pounds per square inch;
t = thickness of flash, in inches;
c = shear expressed as a fraction of the thickness of flash; and
S = shear expressed in inches per foot.

Shear expressed in terms of thickness of the material being cut is more commonly spoken of when referring to the shearing of plate stock.

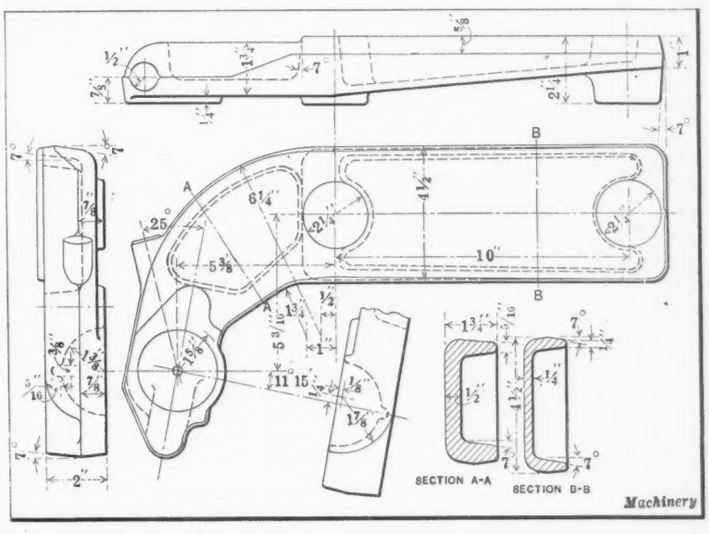

Fig. 11. Radius-rod Bracket for Motor Truck

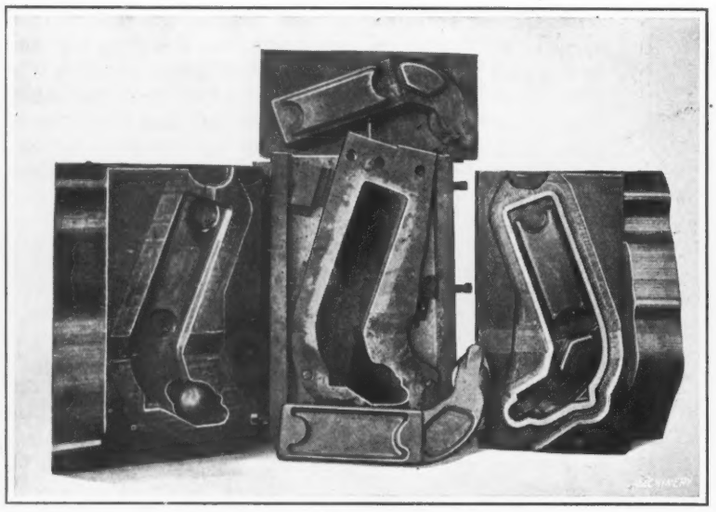

Fig. 12. Drop-forging Dies for Radius-rod Bracket shown in Fig. 11

Under favorable conditions from 10,000 to 12,000 drop-forgings may be cold-trimmed without regrinding the die, and this output is not dependent on the size of the work. Combination trimming punches and dies are sometimes used, if the quantity of work and its requirements should warrant the expense of such equipment. Liberal clearance should be provided for the die openings, in the under side of the die plate, to facilitate forcing the forging through the die opening.

The radius-rod bracket, Fig. 11, is forged from low-carbon steel in the dies shown in Fig. 12. The upper and lower dies are shown at the right and left, respectively, and the trimming die in the center with the punch resting on it. This hot trimmer removes the sprue as well as the flash, which may be done if the forging does not need to be re-struck after trimming. This illustration shows how the die is located in the bolster plate and the adjusting screws by means of which it is aligned with the punch. The holes for the machine screws which fasten the die in place are enough larger than the heads of the screws to allow for adjustment. The face of the punch is shaped to seat evenly in the impressions of the forging. The forging is shown beneath the trimming die.

Much of the information contained in this article was obtained through the courtesy of the Union Switch & Signal Co., Swissvale, Pa., and J. H. Williams & Co., Brooklyn, N. Y. The next article in this series will appear in October MACHINERY, and will deal in detail with modern methods of heat-treating drop-forging dies.

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LOW WAGES IN GERMANY

According to a recent item published in Commerce Reports, an investigation covering a total of 2,300,000 workers in the German metal-working industries shows that, figured in marks, 63 per cent of the workers get eight times the wages they received in 1914, 36 per cent from five to eight times, and the remainder less than five times the wages in 1914. When we compare this with the fact that, still using the mark as a basis of comparison, the cost of living in Germany has increased fifteen times since 1914, it will be readily seen that the actual wages of workers in the German metal-working industries are only from one-third to one-half the amount received in 1914. This is one of the reasons why German industry is able to under-sell other nations in the world's markets. Taking even the highest paid group of workers mentioned in this report, and comparing wages on a dollar basis, we find that they are less than one-half of what they were in 1914, and for the lowest paid workers in the same field they are not much more than one-fourth.

SENSITIVE MEASURING APPARATUS

By J. B. MORAN

The Bureau of Standards is now experimenting with an electrical measuring device which is sensitive to one two-hundred millionths of an inch. While this approaches closely its limit of measurement, it may be adjusted to make much more practical measurements. It represents the greatest advance in mechanical measurement that has ever been made. Credit for the origination of this method is due Professor Whidington of London, England.

Before describing the details of this new development, an example of its unusual sensitivity will be given. Referring to Fig. 1 two ½-inch steel rods *A* and *B* are solidly mounted on a steel base *C*. Attached to one of the rods is a small lever *D*, which may be adjusted vertically. A sliding pan *E* is arranged on this lever. It has been found possible to measure the outward bending of this rod when the infinitesimal weight of one milligram is placed in the weighing pan and the latter is adjusted 5 inches from the rod. At this point of adjustment it is computed that the rod bends outward at its uppermost end one two-hundred millionths of an inch.

The detection of this slight movement has been made possible through the use of the little vacuum tube used in radio work. A non-technical explanation of the functioning of the electrical circuits used should interest mechanical men even though they have no knowledge of radio work. In radio circuits, what are known as high frequency currents are dealt with. These are alternating currents that oscillate to and fro thousands or even millions of times per second. Fundamentally, they are the same as the alternating currents of low cycle used in electric lighting work. The radio currents, however, oscillate at a much higher rate.

Let us imagine that we have an oscillating radio current with a period of 100,000 cycles per second; that is, the current alternates 100,000 times per second. This rapid oscillatory current is generated by the little audion bulb or vacuum tube previously mentioned. Before going further it should be mentioned that such high frequency circuits are very sensitive to changes in capacity and inductance. By capacity, we mean electrostatic capacity which is represented by the condensers in the circuit. By inductance, we might say, roughly, the amount of wire in the circuit.

At the side of the circuit oscillating at a frequency of 100,000 cycles per second, let us set up another circuit exactly the same as the first one except that it oscillates with a frequency of 101,000 cycles. It must be understood that the human ear will not respond to frequencies beyond 10,000. For this reason the currents in both these circuits will be inaudible. When these circuits are placed in proximity to

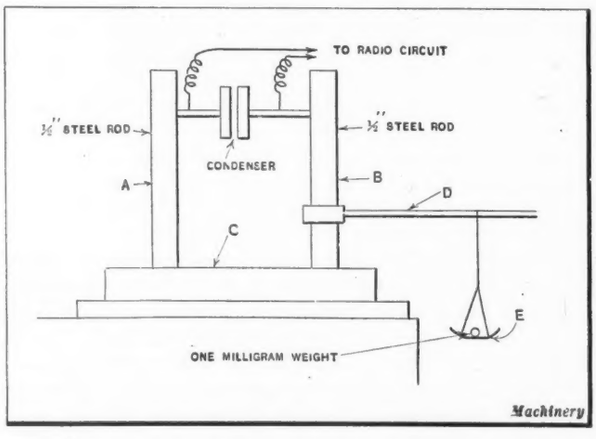


Fig. 1. Equipment used to show Sensitiveness of Measuring Apparatus

each other, however, the oscillating current in one will be superimposed on the other through the property of inductance. This brings about a very interesting result. There is set up in the second circuit what is called a "beat note," and this beat note will have a frequency that will amount to the difference between the frequency of the two oscillating circuits. In this case, the beat note will have an audible frequency of 1000 per second, which is the difference between the 100,000 cycle current in the first circuit and the 101,000 cycle current in the second circuit.

The slight change in the capacity of one of these circuits will change the frequency of the oscillatory current and therefore alter the beat note, which is the difference between the two frequencies. So sensitive are these circuits to changes in capacity that the slightest change imaginable will produce an audible effect in the telephone receivers of the second circuit. The actual measuring instrument used in this electrical device consists of two metal plates which represent the two contacting plates of an electrical condenser. Every change in the distance between these plates will change the capacity of one of the oscillating circuits and thereby produce a difference in the beat note.

Theoretically, a movement of one five-hundred millionths inch is measurable with the device, although one two-hundred millionths inch is the smallest measurement that has yet been made. The actual measurement is made by calculating or measuring the frequency of the beat note. The frequency of the beat note can be measured directly on a frequency meter and the reading of this instrument can be translated to linear measurement. With the proper constants and data available, the measurement of the movement of the plates of the condenser is possible. Of course, one two-hundred millionths inch is a measurement beyond the realm of practice, and this figure is mentioned only to impress the reader with the unusually high sensitivity of the apparatus. The natural expansion and contraction of all substances due to changes in temperature fluctuate so widely that such measurement would not be practical. For instance, with this device the expansion of a piece of steel due to the heat from a human body can be measured.

This measuring instrument is so sensitive that it will measure the deflection of a table top due to the weight of a fifty-cent piece. Fortunately the sensitivity of this electric circuit is adjustable within wide limits, and it may be brought down to a point where it will make practical measurements with absolute accuracy that are beyond the measurements attainable with any known means. If the difference in frequencies in the two oscillating circuits is made greater, the sensitivity of the device is altered accordingly, and comparatively large measurements may be made.

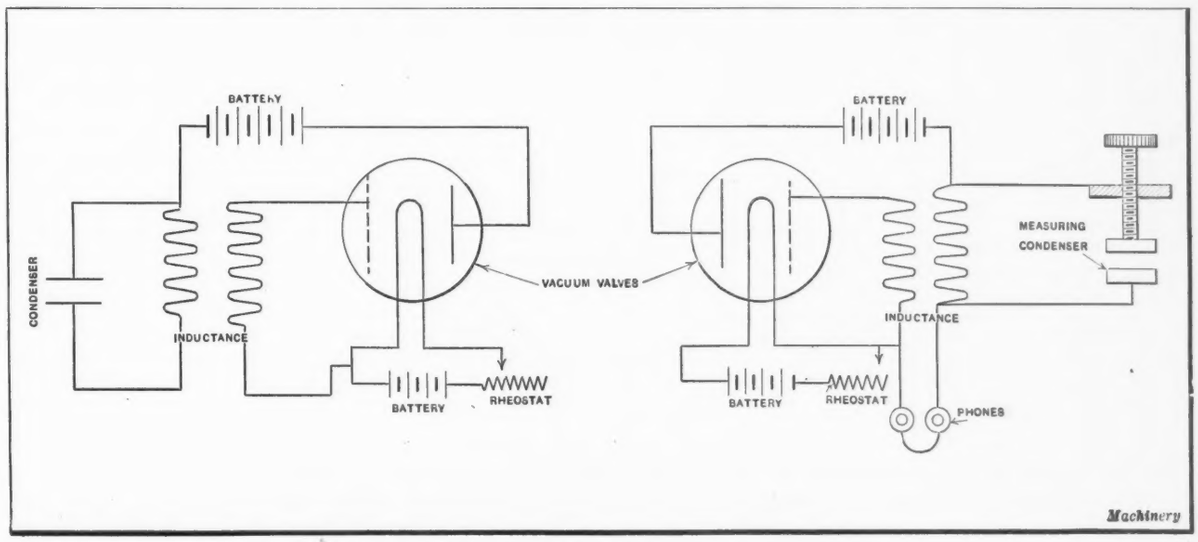


Fig. 2. Wiring Diagram of Electrical Measuring Apparatus

WROUGHT TUNGSTEN

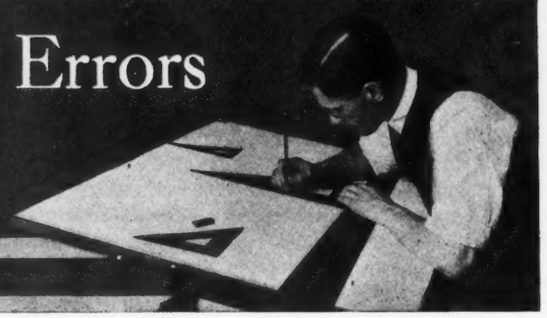
In a review of the results of research work done to produce tungsten lamp filaments of great strength, prepared by Dr. Irving Langmuir of the General Electric Co., and published by the Engineering Foundation, 29 W. 39th St., New York City, many interesting facts relating to this remarkable metal are brought out. Until 1904, tungsten had been known for a century and a quarter only in its unrefined state. Its value as a hardening alloy for steel had been recognized and appreciated; but it was not until 1905 that the metal, mixed with paste and squirted through dies, had given the incandescent lamp its most efficient filament, although the brittleness of this filament caused great embarrassment to electric lamp makers and users alike.

For many years Dr. W. D. Coolidge, of the Research Laboratory of the General Electric Co., had sought a process for making tungsten ductile. The feat was regarded as almost impossible by metallurgists. To make any ordinary metal soft, it is heated to a temperature above its annealing point and then cooled to room temperature. This process, however, left tungsten as brittle as ever. It was eventually found that the only way to make the metal ductile was to mash the grains out into fibrosity and thus make it ductile while cold. This was accomplished by first heating the tungsten to a temperature below its annealing point and then mechanically working it with infinite care at a variety of degrees of heat, each less than the one preceding it, until it was at room temperature. A similar treatment would, if applied to ordinary metals, destroy their ductility.

A process was worked out which, if followed without the slightest deviation, stretched the grains out and the metal was made ductile; but if the working varied from this process, failure resulted. The tungsten would break at a stroke, when cold. Thus, after years of patient labor a triumph of far-reaching consequence in the field of research was attained. The filament produced had a startling tensile strength—about 600,000 pounds per square inch for wire 0.001 inch in diameter. It was so pliable that it could be wound into any form safely.

The tungsten filament has doubled the efficiency of incandescent lamps and provides a white light of far purer quality than any lamp heretofore known. It has provided new targets for X-ray tubes, phonograph needles fifty times as efficient as any that preceded them, better ignition contacts for automobiles, and many other new articles and improvements of old ones. Trained facilities for scientific study and experiment, a spirit of indomitable perseverance, and the facilities afforded by a completely equipped laboratory made this achievement possible.

Common Causes of Errors in Machine Design



Instructions and Standards—Convenient Form for Data—Attitude Toward Errors
Concluding Installment of a Series of Articles

By R. H. McMINN

THE present installment of this series of articles, which began in the January number of MACHINERY, concludes the discussion of the underlying causes of errors in machine design. In the eight articles presented, all the common causes of errors have been classified, and methods have been suggested for preventing the occurrence of each kind of error. The points dealt with in the present article include lack of concentration, reasoning from slight knowledge, systematic methods of applying knowledge, and attitude of employer and employe toward errors.

Systematic Methods of Applying Knowledge and Experience

The lack of a systematic method of applying one's full knowledge and experience is productive of many errors. A designer may have had wide experience, but he must use an orderly system to bring his knowledge to bear in producing the most accurate results in any particular design. Constant reference to a suggestive list of important factors which he has learned may partially determine design is safer than relying on memory to always consider these factors.

A draftsman should therefore tabulate for his systematic use the considerations which enter into the design of machines in general, and as he becomes acquainted with the design of any particular machine, he should tabulate any considerations applying especially to its design. This should be done right after he completes the design or checking of any machine and is most familiar with it. If after completing the making or checking of a drawing, he discovers an error by chance he should try to determine why it was not found by his regular routine system for preventing errors, and should try to incorporate in his system a method for discovery of that kind of mistake in the future without failure. In addition to using a definite system as a guide, he must always bear in mind that unless a machine or a single part to be designed is carried by the mind through all the surroundings with which the machine or part must come in contact, from raw material to operation, conditions affecting design may be overlooked.

Utilizing Experience of Entire Organization

The responsibility in eliminating errors in an engineering department does not rest entirely upon the individual. It should be the aim to have every bit of experience possessed by an organization go into all the methods of manufacture and into all the products, and this cannot be done without a thorough system. One phase of such a system should be in trying to prevent drafting-room errors. This cannot be done solely by constant admonitions to employes to be careful. The system should not be based upon an opinion concerning the accuracy that men of average ability ought to be able to maintain, but upon the discovery that all men are inclined to make errors. Many mistakes can be avoided by recognition of the mind's frailties and the erection of every possible safeguard against error. It should therefore not only be the endeavor to make drawings which are fool-proof for the shop and a machine which is fool-proof for the customer, but to adopt a drafting-room system which, as far as can be governed by methods and general practice, is fool-proof for draftsmen.

Instructions and Company's Standards

Important instructions given by the head of an engineering department to subordinates should be in writing. This not only gives less chance for forgetting or misinterpreting, but incites a tendency to more care in giving instructions as well as avoiding argument as to what they were. Giving full reasons for certain instructions not only may make them more readily understood, but may serve as a guide to a subordinate for future practice. It is often impossible for one receiving instructions to carry them out with the same degree of intelligence that might be used by the one who gave them, unless he knows the result to be accomplished.

A set of instructions consisting of company standard parts and practices, given to men at the beginning of their employment, greatly increases their initial efficiency and accuracy in drawing. Unless there also are written instructions pertaining to determining factors in the design of each type of machine manufactured by a concern, it is impossible for the whole experience of that company to go into each modification of the machine for particular cases, except when the smallest details come under the direct supervision of one man. This man must not only know all necessary facts relating to the design, manufacture, shipping, and erecting of the machine, but he must have a memory so faultless that he will see that no necessary consideration is overlooked in any machine being built. It is evident, in order to insure that he overlooks nothing, that he, at least, requires written data even though it be not for general distribution in the engineering department. If such information be made inaccessible to most of the draftsmen so it cannot so easily get into the hands of competitors, there is a question as to whether this will not prevent most of the men from attaining their maximum usefulness to a concern and thereby offset any possible benefits of secrecy. In as far as possible, it is well to have all useful information relating to one kind of machine grouped together where it will be examined by following a regular routine. If such a collection of data does not contain all the necessary

information relating to a particular machine, it should refer to what the missing data is and where it can be found.

Advantage of Having Data in Convenient Form

Draftsmen will not always go to the lengths necessary to eliminate all doubts regarding a certain point. They realize that they are not expected to spend too much time on any one phase of work. Consequently the head of an engineering department should bear in mind that the easier it is to obtain information, the more likelihood there is of its being used. Therefore, data concerning stock material, kinds of machines in the shop, with maximum size of work that can be handled, limitations in foundry work, and maximum sizes and weights of parts that can be taken into all plant buildings and on all elevators and floors should be easily available. When a change is made in a plant standard or in the design of any standard machine all draftsmen affected should be informed. Likewise all other departments, such as estimating, sales, manufacturing, or any others interested should be notified. All old blueprints or other data affected should be corrected or withdrawn from the departments holding them. A single change may require an alteration in such a large number and so many different kinds of records that it is well to have a standard reference sheet listing all the records which may be affected, so that none will be overlooked.

Standard drawings and bills of material must be kept up to date or prominently marked out of date. In order that draftsmen may know definitely the reliability of any drawing which they may wish to use for reference a list, kept constantly corrected, should give the serial numbers of drawings which can safely be referred to in designing any new machine. A report should be filed in the engineering department regarding the results of operation of each new type of machine built, as well as any special difficulties experienced during manufacture, assembly, shipment, or erection, to show how far a design may be taken as a precedent for future similar machines.

Adoption of Standard Practice

The engineering department should try to eliminate errors by perfecting the routine. Settled standards are a part of a concern's assets. Unsettled features are liabilities. As many things as possible should be settled once and forever —that is, things which could apparently be done in a number of ways with equal success. In order to dimension all parts in the best manner from the standpoint of clarity, and ease of laying out and measuring, every shop should adopt standard methods of giving dimensions on drawings of all representative parts with which it deals, such as gears, shafts, plates, bearings, etc., with instructions that the standard methods shall be followed as closely as practicable. Uniformity of practice should be followed to as great an extent as possible even in small things. Uniformity in the use of words, names, and abbreviations saves time and promotes accuracy. Small, apparently insignificant errors, such as mis-spelled words, should be weeded out to prevent their perpetuation. Changing the pattern number of a part already used promotes error. Changing a symbol number of a part having a certain size should be avoided; thus a certain size crane hook that has been known as No. 25 should not be changed to No. 26 as this invites confusion. Forms for use in the drafting-room should not have spaces too small. This necessitates the crowding of letters, making difficult reading, and promotes error.

Stress of business should not be allowed to interfere with an established routine any more than is absolutely necessary. When drawings are sent to the shop for the work to be started before all related drawings are completed, or when a drawing is sent out without checking, the probabilities are that something will require changing. Interruption of men by change to a new job before completion of another should be avoided if possible, as this disturbs continuity of thought. The amount of work required of men should be considered in its relation to accuracy, as an unreasonable demand will induce a tendency to take chances regarding doubtful points. Absolute harmony in the engineering department and throughout an organization should be sought, as an inharmonious atmosphere is disturbing to the closest attention to one's work.

Attitude of Employe Toward his Errors

When a drafting-room error is not detected until after a machine or part is manufactured, the men who made and checked the drawing are inclined to look for every possible circumstance that may help to exonerate them. But inwardly, at least, they should accept the full weight of responsibility. Each man should try to discover the fundamental law which was violated, so he may observe the law in future related cases, correct the mental habit which made the error possible, or improve his routine system to avoid similar errors.

Attitude of Employer Toward an Error

When an error involving a financial loss occurs, it is not wise for an employer to censure an employe severely who has a good past record of performance, on the assumption that the mistake was due to carelessness. A man may exert care to the limit of his mental capacity and experience, and yet may fail to detect an error in his work. In order to think properly along engineering lines men require equanimity. Severe censure, for a certain error probably lessens the liability of a man's failing to detect that particular kind of error in the near future, but opens the way for a multiplicity of errors along other lines, because of the mental disturbance that has been created in his mind. Unduly emphasizing the occurrence of an error not only destroys the enthusiasm of the individual who made it but that of his associates as well, and lowers the productiveness of all. The loss due to an error should be charged to an account called "Experience." In each case the employer should try to discover if the drafting-room system or data could be improved, and thereby lessen the liability for the recurrence of errors of that class.

* * *

BUSINESS SECURED THROUGH GOVERNMENT DEPARTMENT AID

In a letter sent out by the Bureau of Foreign and Domestic Commerce, attention is called to the fact that the foreign representatives of the Department of State and the Department of Commerce who are engaged in trade-promotion work hear of the results of that work in only a few of the cases handled. Possibly only a small proportion yields results that can be measured in dollars and cents; and it may also be that some of the firms concerned do not wish to divulge the amount of orders received through the information given by consuls, commercial attachés, or trade commissioners. In order to encourage the men in the field to continue to increase their efforts, the Bureau of Foreign and Domestic Commerce asks any firm that benefits in any way from the services of the government representatives abroad to acknowledge this assistance either by writing to the Bureau of Foreign and Domestic Commerce, Washington, D. C., or to the official through whose effort some business may have been obtained. Any information contained in such acknowledgments will be considered strictly confidential.

* * *

According to a recent Commerce Report, a contract has been signed between the Bolivian Government and an American company for the financing and construction of a railway from La Quiaca on the Argentine border, to Atocha, Bolivia, a distance of 126 miles. This is the final connecting link needed to give La Paz, Bolivia, an all-rail route to Buenos Aires, Argentina.

Safety Devices for Power Presses

Guards and Safety Measures Provided for the Power Press Equipment in the Cleveland Metal Products Co.'s Plant, Cleveland, Ohio—Second of Two Articles

IN the first installment of this article, published in August MACHINERY, various types of gate guards were shown. In the present installment, additional types of guards, including the sweeping type gate guard, sliding guards, stationary guards, and guards for shears, will be illustrated and described.

Gate Guards of the Sweeping Type

A positive acting sweeping guard, attached to a Bliss No. 3½ toggle press, is illustrated in Fig. 9, and its method of attaching to the machine, in Fig. 8. The machine is air-operated. The guard is operated by a stud which engages a cam-slot at the upper end, raising and lowering the guard as actuated by the toggle of the press. In Fig. 9 the guard is shown in its closed position, from which it will be apparent that when the ram of the press ascends the gate will swing to the left and expose the dies to view. This type of guard is of simple construction, and has proved very satisfactory in use. Referring to Fig. 8, there is a leather bumper attached to the guard at *A*, and if the operator's hand is in a precarious position prior to the closing of the dies, the guard will sweep the hand out of the danger zone. The construction of this device is so simple that further description is unnecessary.

Stationary Guards for Blanking and Piercing Work

The guard shown attached to the inclinable press in Fig. 10 consists of a framework and reinforced glass. This type is especially suitable for blanking or piercing operations; it permits the work to be observed without obstruction, and at the same time makes it impossible for the operator's hands to extend into the danger zone. The side arms by means of which this guard is attached to the machine are adjustable so that the guard may also be used on machines having a greater stroke.

Another type of glass stationary guard is illustrated in Fig. 12. It will be noted that this guard may be adjusted vertically as required, and that it gives a very clear view of the punch and die. This particular die is provided with an automatic stop so that the stock may be easily fed to the machine by the operator. Fig. 13 shows another type of stationary guard suitable for blanking operations. This guard is attached to the die in such a manner as to just enable the stock to enter, and the space is sufficiently small to exclude the operator's fingers. A guard of this type may be slightly modified in design so that it will entirely enclose the die. This guard is attached to the machine in a different manner from that shown in Fig. 12, but its construction is so simple that it may be applied in a variety of ways to suit the machine and the work.

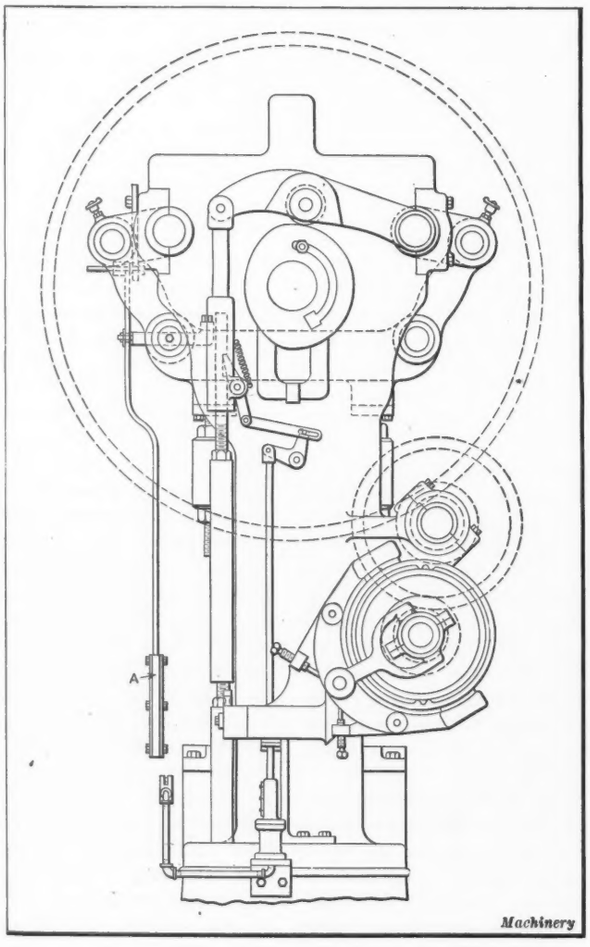


Fig. 8. Method of attaching Gate Guard of Sweeping Type to Toggle Press

Sliding Guard

A guard that is operated by a somewhat different arrangement from that used in other movable guards described in this article is illustrated in Fig. 14. This is a Bliss No. 76½ single-geared press. The guard operates on a track from which it hangs, and is advanced into its closed position, as shown in the illustration, before the ram of the press descends. With the gate open, the operator presses the foot-treadle down, which causes rods *F* and *E* to close the gate by means of lever *G* and to pull roller *D* from engagement with clutch drum *J*. Before roller *D* has been pulled down sufficiently to remove

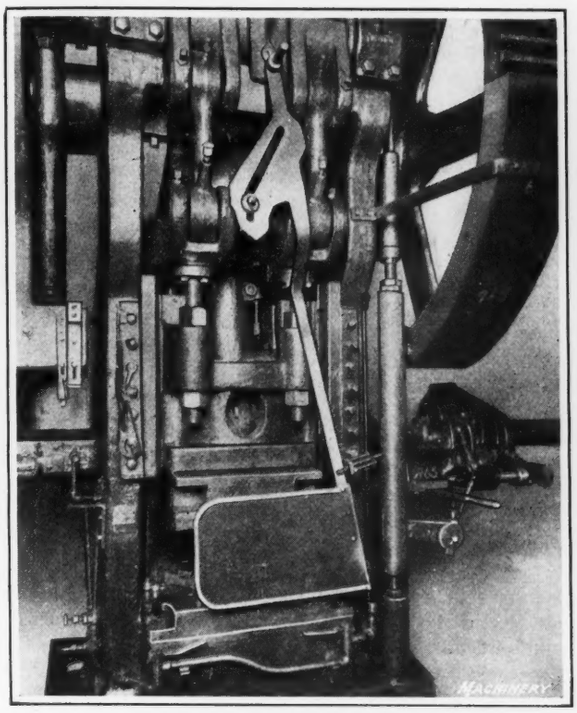


Fig. 9. Application of Sweeping Type of Gate Guard to Toggle Press

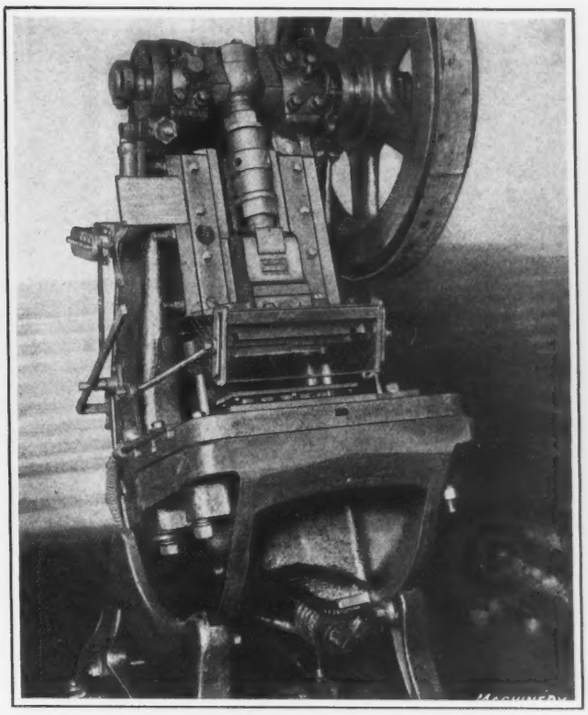


Fig. 10. Inclinable Press with Stationary Reinforced Glass Guard

it from contact with dog *H*, the lever *B* swings forward and locks itself under weight *C*. This constitutes a lock for the gate, the locking movement occurring just before roller *D* is pulled entirely away from contact with dog *H*. The clutch will not engage until roller *D* has been completely disengaged from dog *H*, at which time the press will trip. The gate is held in the closed position

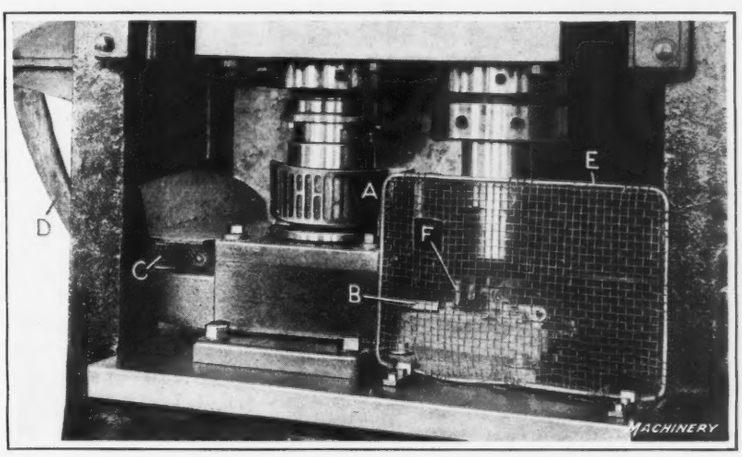


Fig. 11. Guard for a Double-action Press employed for Blanking, Drawing and Redrawing Operations

until the ram is about to be raised, at which time cam *A* operates lever *B*, permitting the weight to drop; this brings roller *D* into contact with the clutch drum *J*, and the clutch is disengaged as soon as dog *H* contacts with the roller. In the meantime, the raising of roller *D* has lifted the foot-treadle and returned the gate to the open position. It will be readily seen that the arrangement of

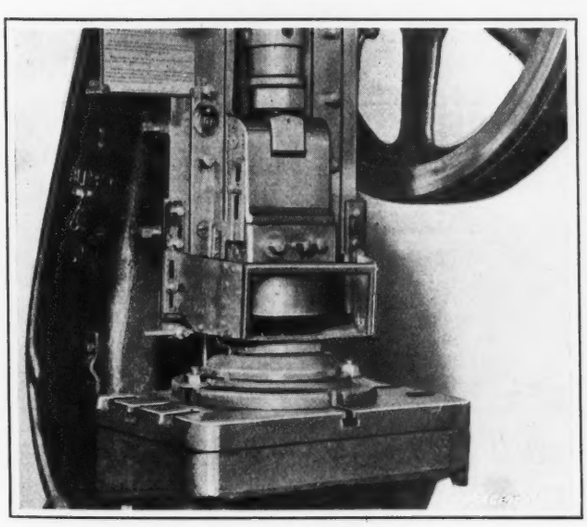


Fig. 12. Stationary Glass Front Guard which may be adjusted for Various Heights

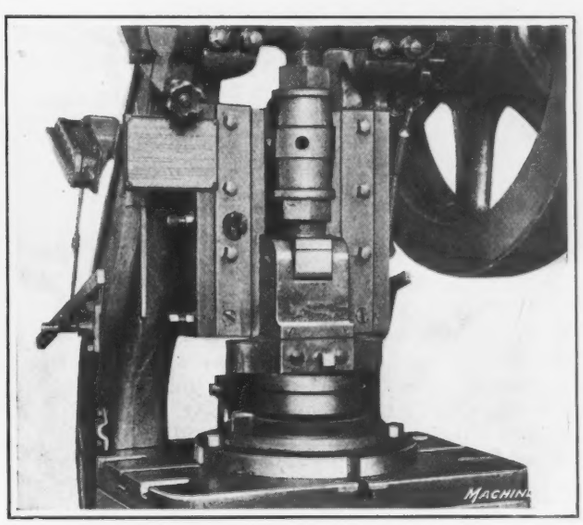


Fig. 13. A Type of Guard Suitable for Blanking and Piercing Operations

the levers that control the sliding of the gate is such as to make it improbable that the operator would slide the guard manually to expose the dies, for in so doing he would need to exert enough pull to lift the foot-treadle which is practically impossible to do, on account of the connection to the clutch mechanism.

Stationary Guards for Double-draw Press

A Bliss No. 353 double-draw press, properly guarded, is illustrated in Fig. 11. The blanking and first drawing operation is performed by the punch and die shown at the left-hand side of the machine. The punch is protected by a stationary sheet iron guard *A*, which practically encloses the entire distance between the punch and the die, leaving only a ⅜-inch opening for feeding the stock under the guard. The partially drawn blank is pushed down into an opening in the die-block, where it is picked up by a pusher *F* on the end of reciprocating ram *B*, which may barely be seen through the hinged guard *E*. This pusher *F* is connected to link *C*, so that it may be

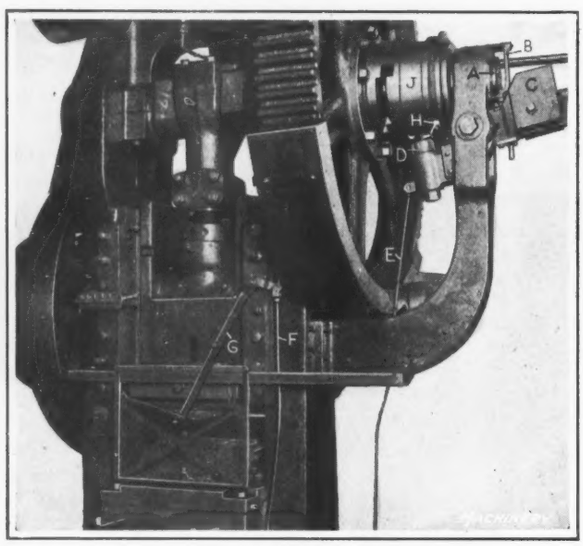


Fig. 14. Sliding Gate Guard, actuated from the Press Clutch

operated by lever *D* with each throw of the crank. It is rarely necessary to swing the guard *E* down, because the drawn shells do not need to be handled, for they are pushed through the die and deposited in a receptacle at the rear of the press. This guard may be readily swung forward however, as it is provided with spring hinges which hold it in an upright position against the frame of the machine. A combination of two guards such as this is very effective, and may be applied to blanking and redrawing dies of numerous types.

Guard for Shear

In the operation of the square shear shown in Figs. 15 and 16, provision has been made for guarding the shear blade so that the work may be cut rapidly without the possibility of the operator's fingers being injured. Only a ⅜-inch opening is allowed for stock between the bed of the machine and the guard when the arch bracket is raised. This prevents the operator's fingers from getting under the shear blade. Fig. 15 shows a front view of this machine, to the arch bracket of which a guard *A* made of channel iron, with elongated slots in it, is hung by means of bolts passing through the slots. This construction is very simple. As the shear descends the lower flange of the channel iron rests on the work and precludes all possibility of the fingers coming into contact with the blade. This arrangement does not curtail the output, but rather is an aid in increasing the speed at which the shear may be operated. At the rear of the machine, Fig. 16, a chute *B* may be seen attached to the head of the shear so that the stock may be fed rapidly under the blade and against a stop at the front without danger to the operator.

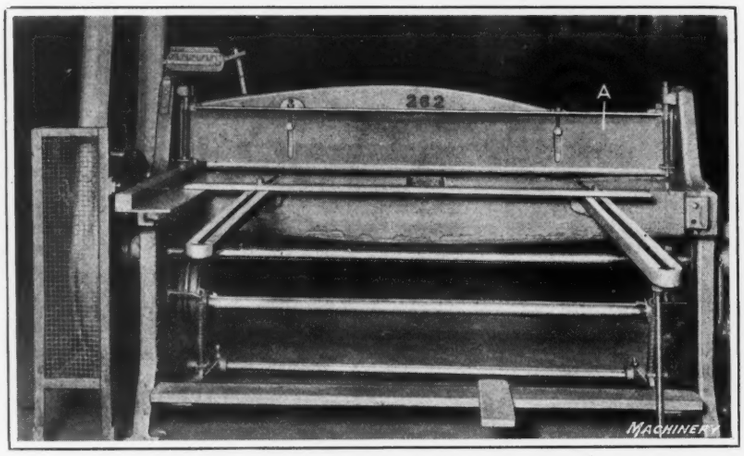


Fig. 15. Front View of a Square Shear with Guard attached to Arch Bracket

All power presses, shears, etc., in this press department are equipped with individual or group motor drive, to suit the machine lay-out, which is another feature adding to the general safety of the machine operators.

* * *

At the annual meeting of the German Machine Builders' Association (not the German Machine Tool Builders' Association, which is another organization), it was stated in the annual report that 700,000 men are now employed in the machine building industry in Germany, and that the association has 944 individual firm members with 40 additional branch works, representing over 550,000 employes. Since October, 1920, the monthly average has been 20,000 export orders distributed between the members of the association. The industry exported, in 1920, machinery valued at 6,000,000,000 marks (about $75,000,000 present exchange). There has been a decrease in the export business during the present year, and poor business conditions have been met with all around. The main subjects of discussion at the convention related to methods for holding Germany's export markets in machinery, and for producing more economically.

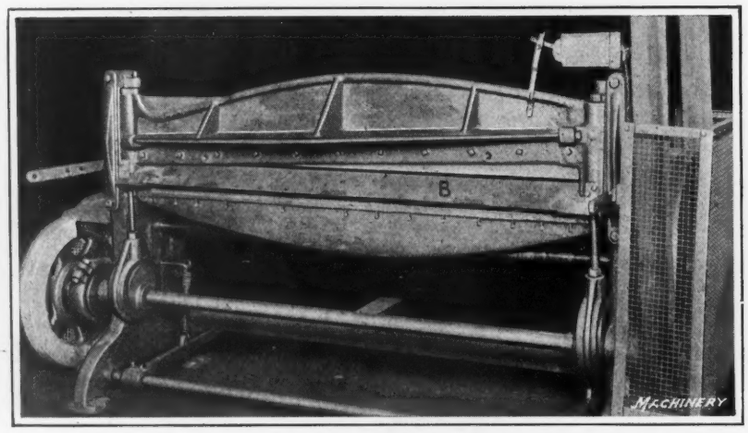
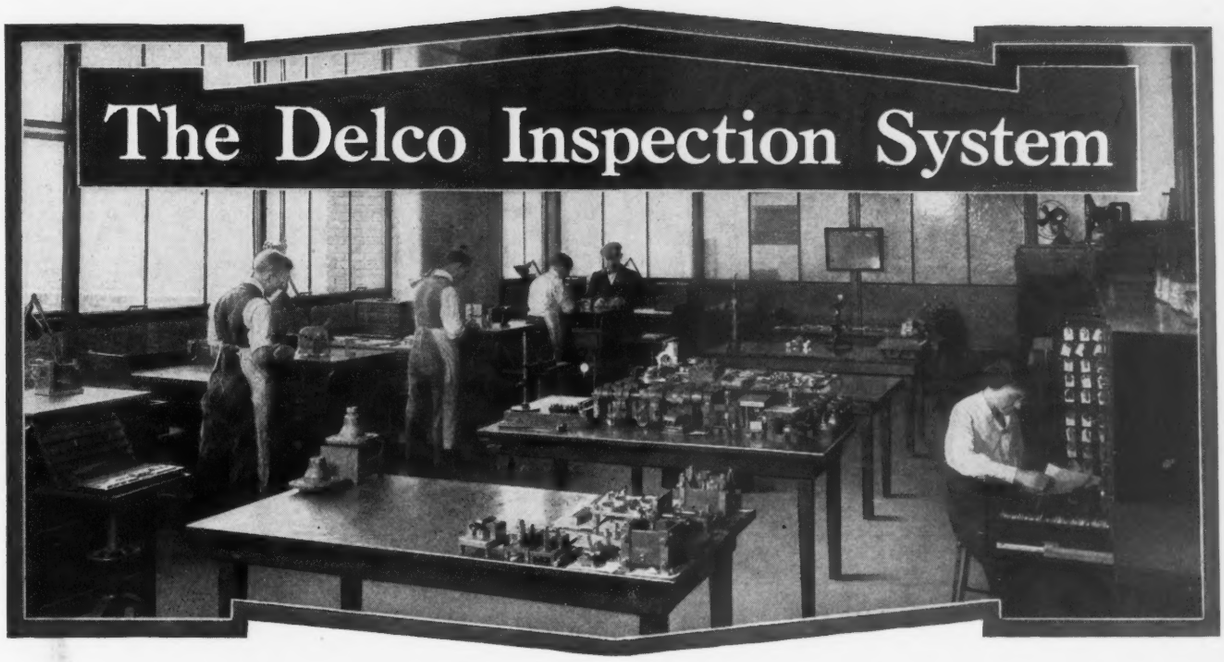


Fig. 16. Rear View of Shear illustrated in Fig. 15, showing Chute provided to facilitate feeding the Stock



The Delco Inspection System

Typical Examples of Gaging Fixtures Used by the Dayton Engineering Laboratories Co. in the Manufacture and Inspection of the Company's Product—Second of Two Articles

By ERIK OBERG

IN the first article on typical examples of gaging fixtures, published in August MACHINERY, concentricity gages, gages for motor generator frames and distributors, and recess gages were dealt with. In the present article a number of additional fixtures and gages will be described, including a spring testing fixture, a gage for testing installation conditions of motor generators, amplifying gages, device for testing the spacing of ignition cams, plate gages for the automatic screw machine department, gear-testing devices, limit gages for rollers, etc.

Spring Testing Fixture

The spring testing fixture illustrated in Figs. 14 and 15 is used for testing the automatic advance spring on the distributor of a Delco ignition system. It tests the loads at two given compressions of the spring. For example, the spring is compressed to a height of 1 inch, at which it should register a certain load. It is then compressed to, say, ¾ inch, at which it should register another definite load. The base of the device is a weighing scale, and the loads are registered on the dial of this scale. Referring to Fig. 15, *C* is a rack by means of which pressure is applied to the spring by rotating the handwheel. At the upper end of the rack there is a pointer *F*, which indicates on a graduated scale on rod *A* as the spring is compressed. The lower end of the rod rests on the platform of the scale so that it is free to move up and down with it.

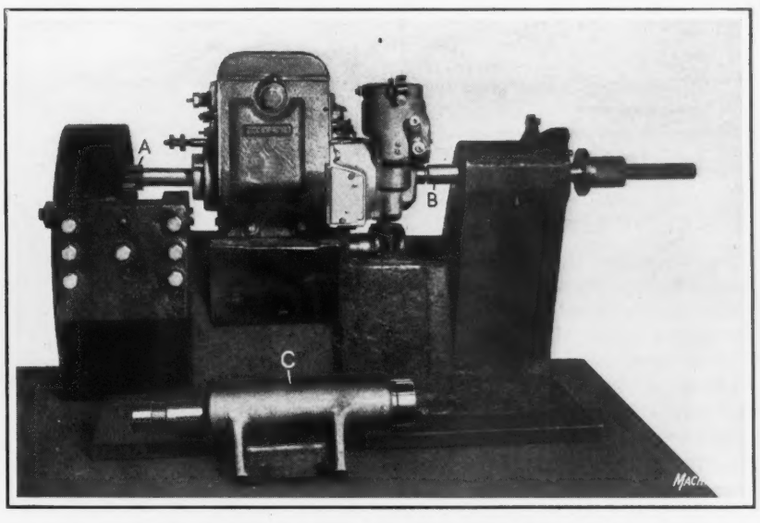


Fig. 13. Running-in Gage for testing Installation Conditions of a Motor Generator

In making use of the device, pointer *E* is first set to the correct graduated scale reading for the compression required. Rack *C* with pointer *F* is then moved down by means of the handwheel until the spring has been compressed beneath face *D* to the proper length. Then the weighing scale is read for the applied load. Rack *C* is then moved downward to compress the spring further, until pointer *F* coincides with pointer *G*, which has been set to the correct scale measurement, and the reading on the weighing scale indicator is again noted. It will be evident that pointers *G* and *E* can be independently adjusted to agree with any desired compressed lengths.

Testing Tension Springs

The auxiliary testing unit shown resting on the platform of the scale in Fig. 14 is used for testing tension springs by the aid of the device just described. The fixture, which is more clearly shown at *B* in Fig. 15, is set on the platform of the weighing scale so that surface *D* bears upon surface *H* of the auxiliary device. The spring to be tested is fastened to two projecting studs *I* and *K*, *I* being attached to part *H*, and *K* to the base of the auxiliary device. Stud *I* is then actuated by rack *C*, and the pull on the spring is transmitted through stud *K* to the platform of the weighing scale. It is evident that the application of the device is otherwise the same as that described for testing compression springs.

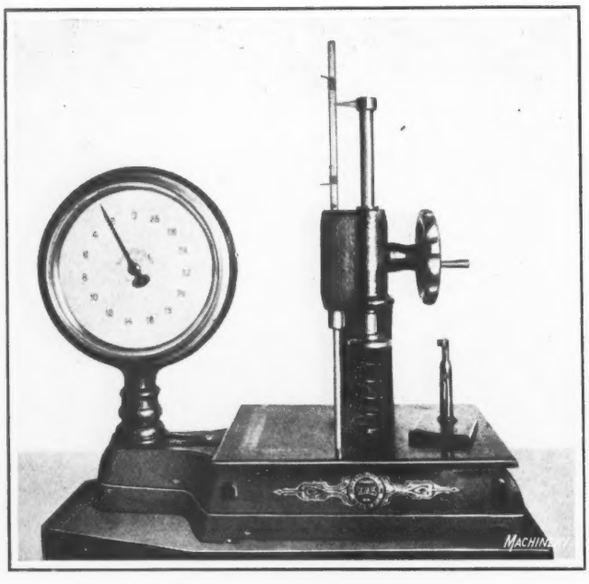


Fig. 14. Spring Testing Fixture

Gage for Testing Installation Conditions of a Motor Generator

The gaging fixture shown in Fig. 13 is employed for checking the relation of the center line of the armature of a motor generator to the center line of the crankshaft, and for detecting backlash between the armature pinion *A* and the

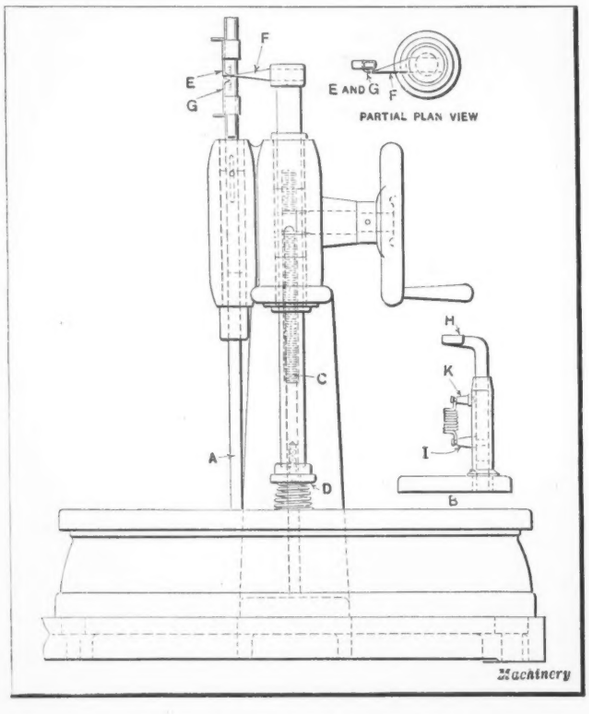


Fig. 15. Assembled View of the Spring Testing Fixture and Auxiliary Gaging Device for Coil Tension Springs

starting clutch gear. Also, when the motor generator is located properly in the gaging device, it is checked for gear noise, by running the motor generator as a motor from a storage battery. For testing the gaging conditions of the fixture, the master gage *C* is used, being mounted on the fixture with its shaft in the same relative position as that occupied by the armature pinion shaft. After the device has been located in this manner, it is replaced by the motor generator to be inspected. This fixture enables the actual installation conditions to be checked. The aligning gage *B* checks the center line of the coupling in the generator clutch with the center line of the pump shaft coupling.

Amplifying Gages

Figs. 16, 17, and 18 are views of three "American" amplifying gages—made by the American Gauge Co., Dayton, Ohio; these are used for the gaging and inspecting of different classes of work in the Delco plant, including practically all cylindrical work inspected in the grinding department. Fig. 16 illustrates the method of gaging cylindrical surfaces. An anvil is provided on which the work rests while it is rolled under the gaging point. A set-block gage is employed for first setting the dial of the amplifying gage to zero. This means of inspection provides a simple method of determining whether the work is within the required limits.

Fig. 17 shows the same type of gage applied to work held on centers for gaging the concentricity of the work in rela-

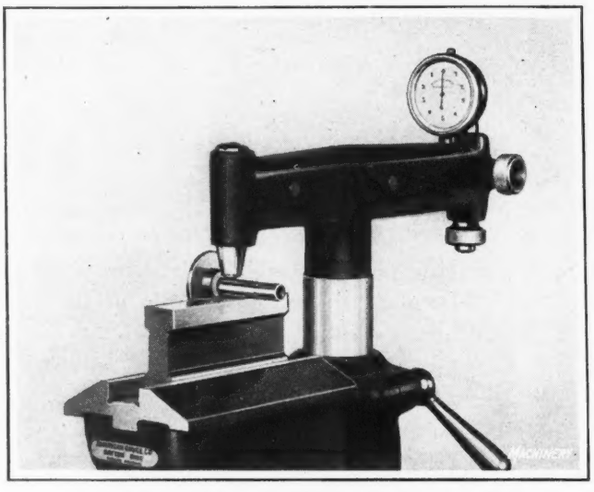


Fig. 16. Amplifying Gage for Small Cylindrical Work

tion to the centers, and Fig. 18 is a similar type of gage employed for testing lobes of cams. One cam lobe after the other is passed under the gaging point, and the limits of accuracy are thereby quickly inspected.

Testing Spacing of Ignition Cams

Figs. 19 and 22 show an interesting device for testing the spacing of lobes or "breaking points" of cams for ignition distributors. The cam is secured on a central stud which

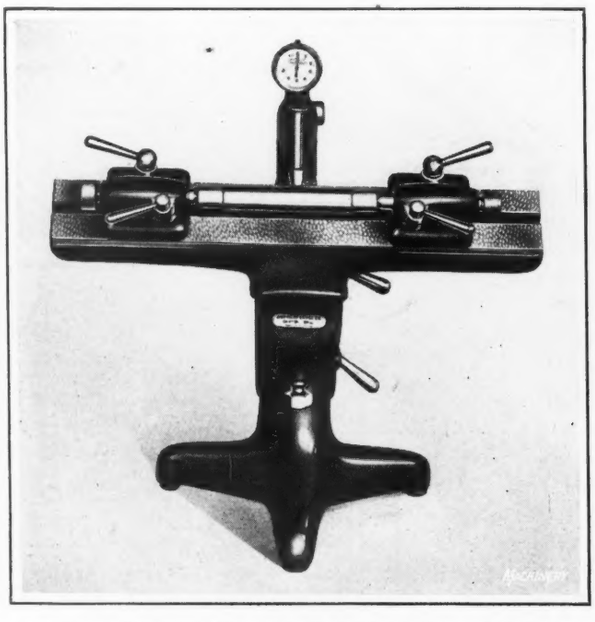


Fig. 17. Amplifying Gage used for inspecting Work held between Centers

is firmly fastened to the fixture. The dial *A*, which may be freely revolved, is mounted on a sleeve having a good running fit on the central stud. The dial is graduated around its outer edge in degrees. The fixture is provided with breaker arm *B* so that when the graduated dial is revolved, each lobe of the cam will cause the breaker arm to break contact and open an electric circuit, thereby extinguishing an indicating light. The cam is so set that the indicator points at zero with the breaker arm at the high point on one of the lobes and with the light out. As the dial is revolved about the cam, which is held tightly on the central stud by friction, if the lobes of the cam are accurately spaced, this is indicated by the fact that the light will go out at 45-, 60-, or 90-degree spaces, according to whether there are four, six, or eight lobes on the cam.

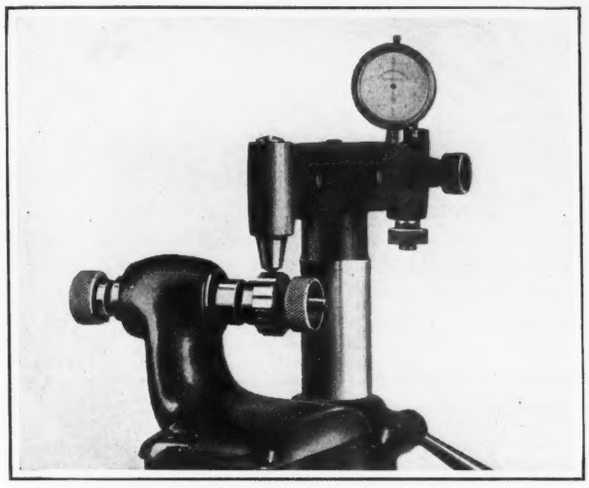


Fig. 18. Testing Lobes of Small Cams on Amplifying Gage

Plate Gages for Automatic Screw Machine Department

The examples shown in all the previous illustrations have been of inspection gages for the final inspection of assembled mechanisms and parts. A number of gages are used in the manufacturing departments both as working gages and as inspection gages that have a great deal of interest. One of these gages, shown in Figs. 20 and 21, is a plate gage for testing a shell after it has been finished in the automatics.

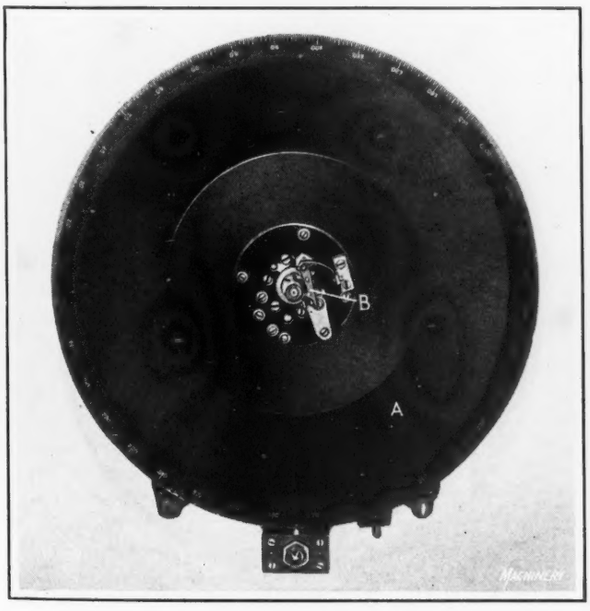


Fig. 19. Fixture for testing the Spacing of Lobes on Ignition Distributor Timing Cams

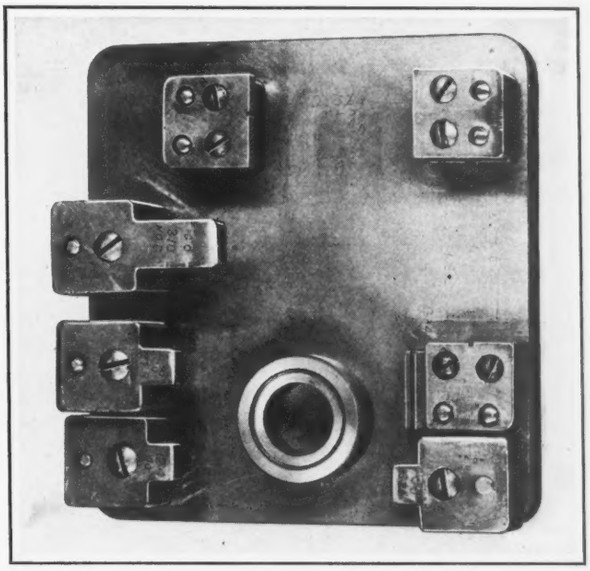


Fig. 20. Plate Gage for inspecting a Clutch Shell

The fixture consists of a plate with a number of gage-blocks screwed to it, which constitute limit gages for different dimensions on the work. The center hole *G* of ring *A*,

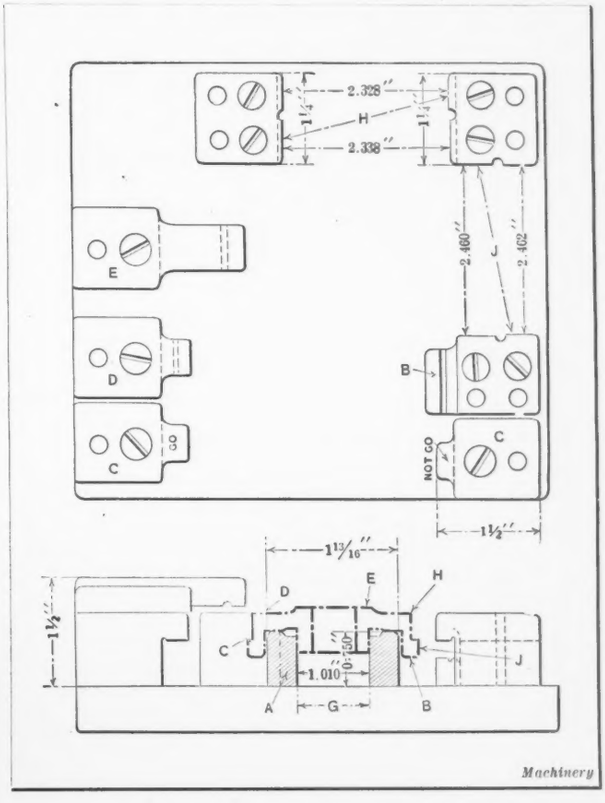


Fig. 21. Details of the Gage shown in Fig. 20

Fig. 21, is the "Go" size for the hub of the piece. The part, shown in dot-and-dash outline, is mounted on the gage-ring *A*, and is then slid under or between the various gages, as indicated by the corresponding letters in the elevation and plan view. The shoulder *C* in the elevation, for example, is gaged by the "Go" and "Not Go" gages *C* in the plan view; the shoulder *D* in the elevation by the limit gage *D* in the plan view; the face *E* by the limit gage *E;* the diameter *H* by the limit gage *H;* the diameter *J* by the limit gage *J;* and the surface *B* by the limit gage *B*. After the parts to be gaged have thus been moved around the gage plate and gaged on the various dimensions, plug gages are

used to gage the center hole, thus completing the cycle of inspection operations. No further checking is necessary until other operations are performed on the piece. This group arrangement of inspection operations eliminates considerable inspection labor, and thus saves time.

Gear Testing Devices and Clutch Roller Gage

Fig. 24 shows two simple gear testing fixtures intended simply for determining the free running qualities of gears. The fixture at the left is for spur gears, and the one at the right for spirals. The tooth thickness of the gear to be tested has previously been inspected, and the test for running qualities merely shows that the gears will assemble in the mechanism for which they are intended, without binding; that is, the center distance between the two studs on which the gear to be tested and the master gear are mounted during the test are placed at the minimum limit of the center distance in the frame into which the gears are finally assembled. The master gear used in the test, with which the gear to be tested runs, is made to the maximum limit of tooth thickness and outside diameter. In testing a gear in this way, there is absolute assurance of the free running of the tested gear.

The spiral gear testing fixture at the right tests the running qualities of spiral gears on the same principle as the spur gear fixture operates. The master gears both for the spur and spiral gear testing fixture are made soft, and are duplicates of the gears with which the gears being tested are to run, except that they are made to the maximum limits as already mentioned. To make sure that they represent in every way the actual working gears, they are cut on gear-cutting machines the same as the mating gears that will be assembled in the mechanism. These testing fixtures are used both for gears and for pinions, by simply changing the position of the masters.

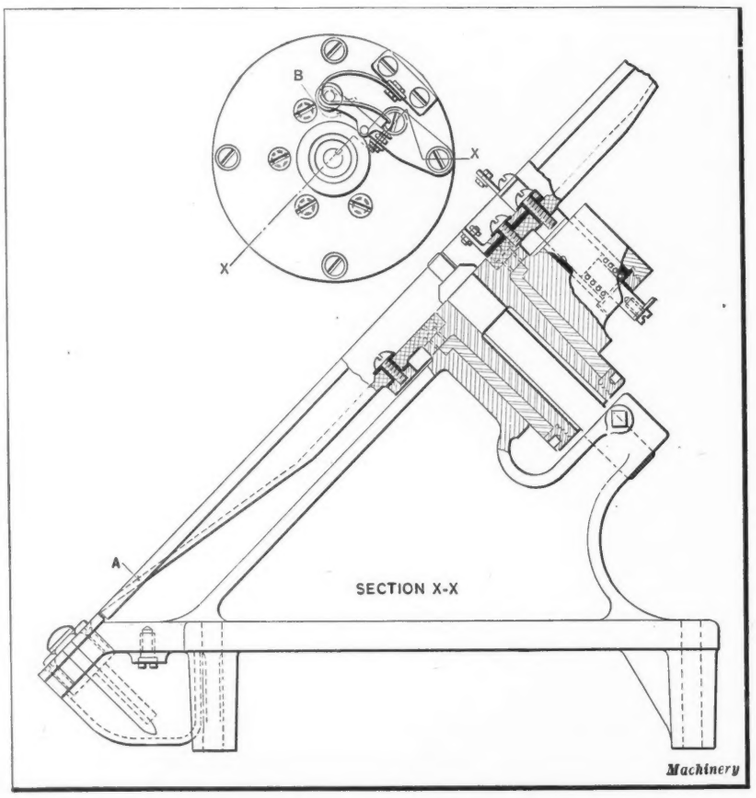


Fig. 22. Sectional View of Lobe Spacing Inspection Gage shown in Fig. 19

A gage for checking lengths and diameters of rollers for clutches is shown in Fig. 23 and in the upper part of Fig. 25. This gage could be equally well applied to the testing of rollers for roller bearings or various other purposes. The roller is put into the gage in the receptacle shown at the left end in Fig. 23, and is then pushed through a hole and into a groove formed by gaging plates assembled on the baseplate. Block *A*, Fig. 25, permits the gaging of two different lengths of rollers, the block being removed or left in place, according to the size to be gaged.

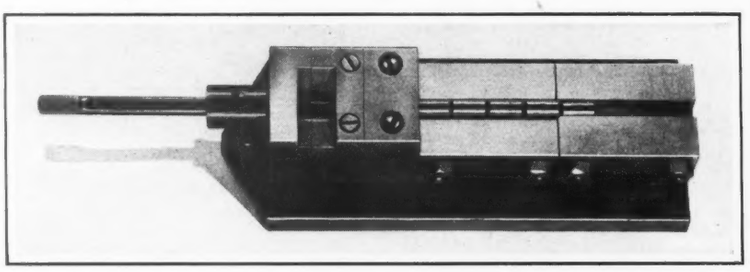


Fig. 23. Gage built up of Plates, which checks the Length and Diameter of Clutch Rolls

The object of the gage is to prevent the passing of rollers that are too long, in which case they are unable to enter the gage at the receiving end. If the rollers are somewhat shorter than the opening in the gage, no harm is done; hence the gage checks only the maximum limit in regard to length. The roller, having dropped into the receptacle at the end, is pushed along by the plunger shown. If it is too small in diameter, it will drop through the opening at *C*, Fig. 25, which is set to the minimum limit. If it does not drop through here, it will pass along between the plates until it reaches section *D*, where it will drop through if it is within the maximum diameter limits. If it is too large in diameter, it will not drop through here, but will then be passed over the gage and ejected at the end. When worn, the gage parts at *C* and *D* can be readily removed, relapped, and replaced.

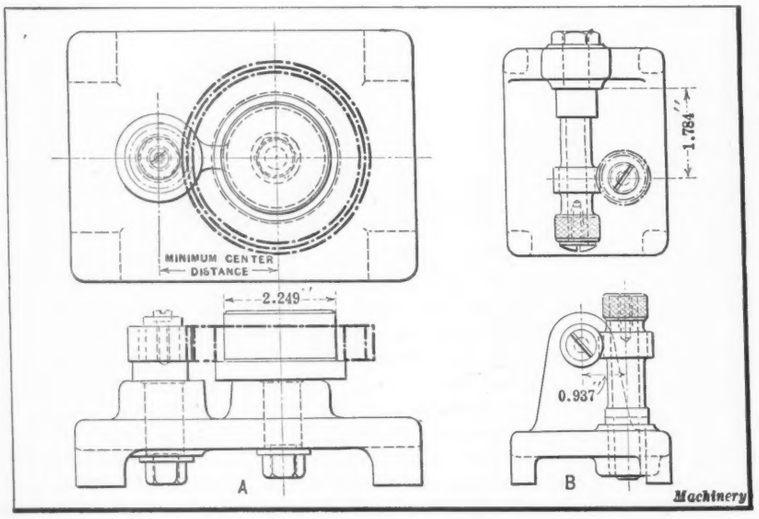


Fig. 24. Gear Testing Devices

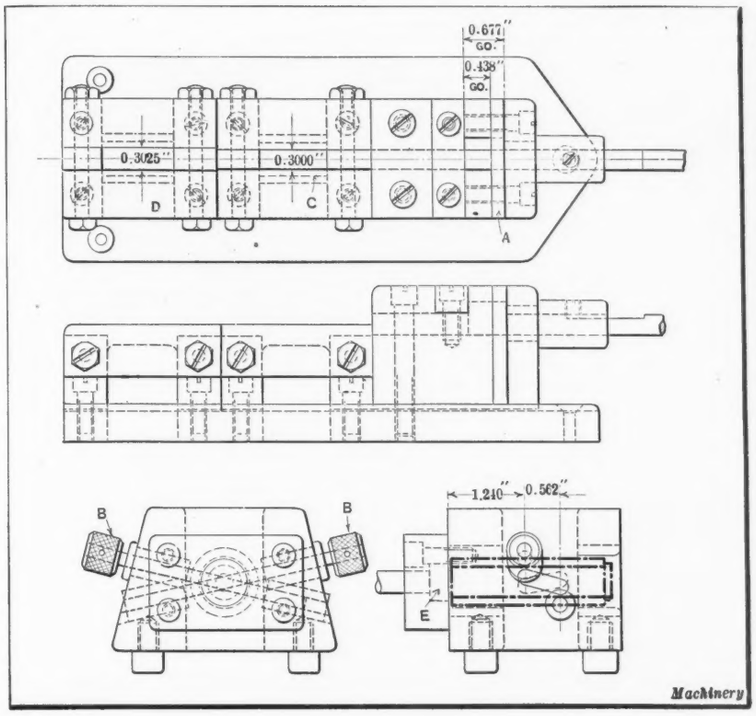


Fig. 25. (Above) Detail View of the Roll Gage shown in Fig. 23. (Below) Gage used for testing the Spiral Slots in a Sleeve

Testing Spiral Grooves in a Sleeve

An unusual type of testing fixture is shown in Fig. 26 and in the lower part of Fig. 25. These gages are used for gaging the location of two spiral grooves in a sleeve, the sleeve being shown in the upper part of Fig. 26. In this sleeve there is one spiral groove on each side that must have a definite relation to the groove on the other side. The relation of these grooves to the center hole of the shaft as well as to the outside diameter and ends of the shaft is also checked by this gage. To test this part it is passed through a hole in the gage, as more clearly shown in Fig. 25, where the sleeve is indicated by dot-and-dash outline, and pushed against a stop *E* at one end, which also acts as an ejector after the gaging. With the part in place, the two plungers *B* are pushed in. These must be able to pass clear through the spiral slots in the piece. The fixture shown in Fig. 26 is used for gaging spiral grooves and for additional gaging of the work. With this fixture the testing of the milled grooves at the other end of the piece is accomplished by means of plungers *C*. Plunger *D* is a "Go" and "Not Go" gage, which tests the length of the part.

* * *

THE RIGHT ATTITUDE TOWARD THE JOB

By WILLIAM C. BETZ

During the present business depression any man having a job should realize that it is to his advantage to do all in his power to produce work economically, because costs must be cut in order to bring back business. He must understand that wages will have to come down with other things. A man is injuring his own chances by nursing a grouch, lying down on his job, or criticizing the management because of the necessity of reducing hours of work, or wages, or both.

A great many workmen today apparently believe that manufacturers are holding up orders with a view to bringing down wages. To believe such statements is the height of folly, for surely no manufacturer would tie up his equipment while paying taxes, insurance, interest, and many other expenses which must be paid whether the plant is in operation or not. Any thinking man will find it impossible to believe that the firm should go on losing dollars in that way in order to gain cents.

The firm with which the writer is connected is doing everything in its power to obtain business to keep its steady and capable employes busy, and any man who has the least idea about business should be able to understand that no firm would refuse an order in these times. It is a case of the survival of the fittest, both as regards firms and individuals, in the machinery business for years to come, and the man that goes to work with a determination to produce better and cheaper than he has ever done before is the man who is going to be kept on the payroll as long as the firm can keep that payroll going.

It may be of interest to state a comparison of prices of goods manufactured in this country and in Europe. A firm in Milwaukee is making a certain device which it cannot sell, according to its own statement, for less than $120, and yet the best possible equipment is being used in its manufacture. A German firm, after paying transportation and tariff on an identical machine, sells it in the United States for $22.50. This should bring home to the American workman the necessity for cutting costs to the core.

It has often come to my notice that the men who are the most fault-finding about working conditions and wages and who deliberately lie down on the job, are the men who feel that a great injustice has been done to them when they are laid off on account of lack of work.

* * *

The oldest iron manufacturing plant in Austria, employing furnaces using wood charcoal, has been in operation for over six hundred years, according to a Commerce Report. This plant, which is located at Vordenberg, was forced to shut down three years ago by being supplanted by the larger furnaces at Donawitz which employ coke as fuel. As a result of the present difficulty of securing coke, however, work has been resumed at the Vordenberg plant where five carloads of pig iron per day are being produced at about the same cost of production as at the Donawitz plant.

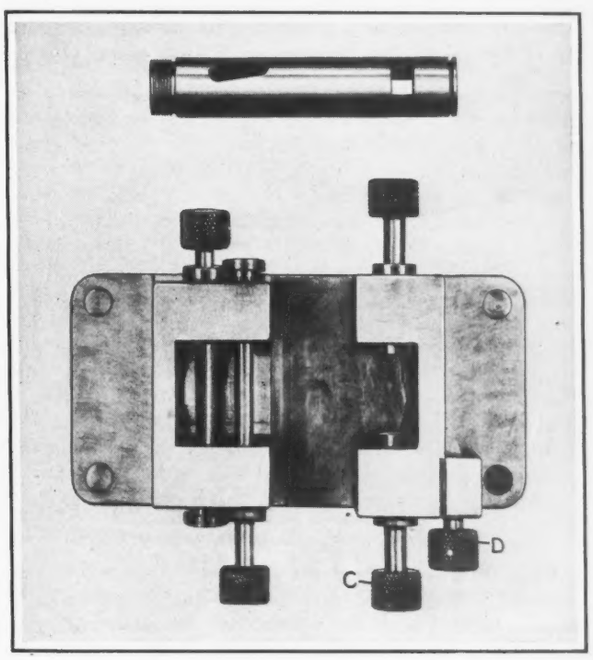
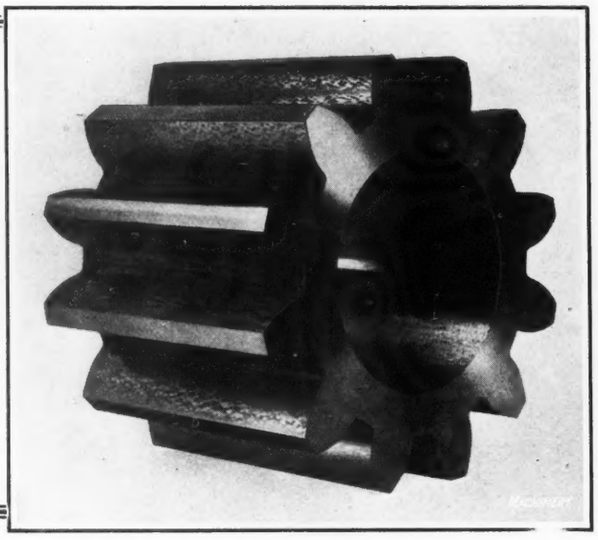


Fig. 26. Sleeve with Spiral Slots, and Gaging Fixture by Means of which it is inspected

Principles of Maag Gearing

An Analysis of the Maag System of Gearing, Advantages that are Claimed for this Type of Gears, and Machines for their Production



THE main objective in choosing a curve for the profile of gear teeth is the fulfillment of the requirement that two toothed wheels, when meshed together, shall have the same relative angular velocities as two given disks would have if their edges touched and no slipping took place. Theoretically, a variety of forms can be given to the teeth of one gear from which complementary teeth can be determined for the other so that the required ratio is obtained. The curve obtained by rolling a circle of infinite radius on one of finite radius is known as the involute. Its advantages for tooth form are well known; not the least is the fact that the center distance between two meshed gears with involute teeth can be varied, so long as the involutes are in contact, without disturbing the constant relative angular velocity of the gears. The only requirement for maintaining this constant relation between gears is that at any moment the common normal to the contacting faces must, if produced, pass through the pitch point or point of contact between the imaginary disks.

Difficulties Encountered with 14½-degree Pressure Angle

With involute teeth, provided the center distance is maintained, these normal lines are always coincident, and the usual practice has been to so form the involute that this normal is inclined at 75½ degrees to the common center line of the gears, the pressure angle thus being 14½ degrees. The normal is tangent to two base circles concentric with the imaginary disks, the base circles being of the same proportionate diameters as the disks and of such size that the tangent touching each is at an angle of 75½ degrees with the center line of the gears. Other angles besides 75½ degrees have also been used as standards.

The strict adherence to a common normal or pressure angle of 14½ degrees brings with it endless difficulties in gears with few teeth, and all sorts of "corrections" have been suggested to overcome them. Since the base circles to which the common normal is tangent must be in a strict relation to the velocity ratio desired, it follows that, if normal proportions of addenda and dedenda are followed and one gear has very few teeth while the other has a large number, the base circle of the smaller gear will be very near to the pitch circle, while the base circle of the larger gear will be relatively further from its pitch circle. Since the involute curve cannot exist within the base circles, it follows that only a very short portion of the teeth of the small gear below the pitch circle will be of involute form. Another difficulty crops up since the crests on the tooth addenda of the larger gear sweep out more or less of the bottom of the teeth on the smaller gear, under-cutting them so that not only are the teeth weakened, but in gears with few teeth, part of the involute, short as it is, is also

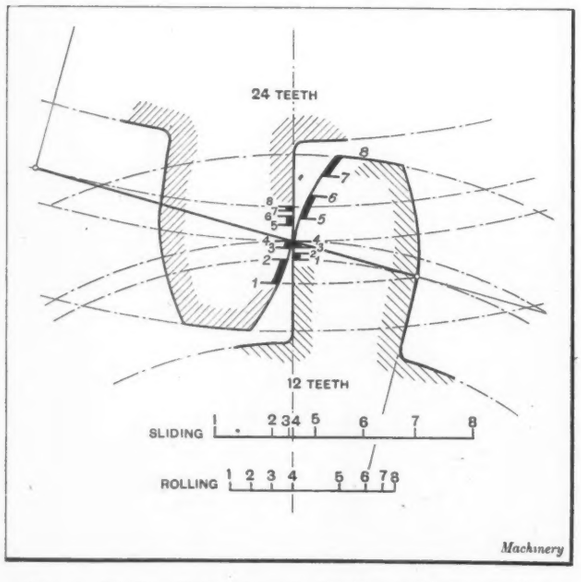


Fig. 1. Diagram showing Amount of Sliding and Rolling Contact on Gear Teeth having a Standard 14½-degree Pressure Angle

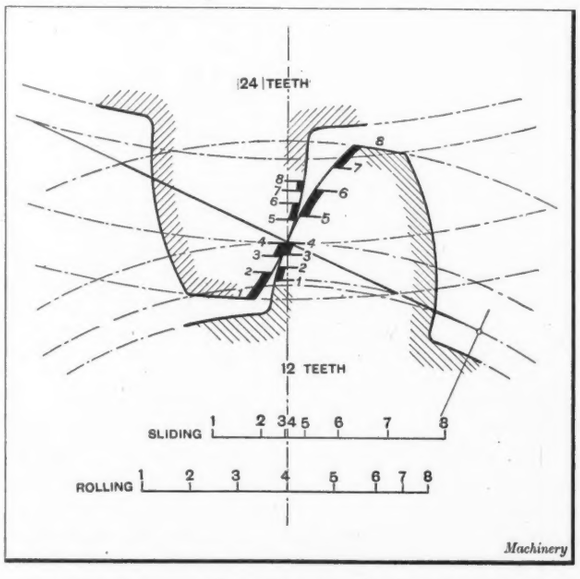


Fig. 2. Sliding and Rolling Contact on Teeth of Gears of Same Ratio as in Fig. 1, but with a Pressure Angle of 22 Degrees 55 Minutes

removed and, therefore, this important part near the pitch circle is of no purpose. For these reasons, pinions with a smaller number of teeth than twelve have not been recommended.

Effect of the Pressure Angle on the Shape of the Teeth

In Fig. 1 are shown teeth of a 12-tooth pinion and a 24-tooth gear in mesh; the common normal passes through the pitch point and is tangent to both base circles. The pressure angle is drawn at 14½ degrees. It will be noticed that in each case a large proportion of the tooth flanks is below the base circles, and therefore cannot be involute. This is especially the case with the pinion tooth. Fig. 2 shows teeth of gears having the same ratio but with the pressure angle and tooth proportions chosen to give a better shaped pair of teeth. In this case the pressure angle is 22 degrees 55 minutes. It will be noticed that a reduction in the diameter of the base circles improves the tooth shape, and it is interesting to compare the usefulness of these profiles with those in Fig. 1.

By dividing into three equal parts the profile of the pinion between the pitch and base circles (Fig. 1), and striking from the center of the pinion circular arcs from these divisions to the normal line, the position during rotation at which these several points will contact with the other tooth face may be determined. From the points located on the normal line, draw arcs about the gear center to the tooth flank of the gear. In this way the corresponding points of contact are obtained. Thus, points 1, 2, 3, and 4 on the pinion tooth contact at points 1, 2, 3, and 4, respectively, on the gear tooth. It will be seen that about one-half of the addendum of the gear tooth is useless. By dividing the addendum profile of the pinion tooth into four equal parts and proceeding as before, contact points 5, 6, 7, and 8 on the pinion tooth, and 5, 6, 7, and 8 on the gear tooth may be obtained. By proceeding similarly with the teeth shown in Fig. 2 the better utilization of the tooth faces in this illustration will at once be apparent.

Comparison of Sliding and Rolling Contact

Again, by comparing the distance between points 1 and 2, 2 and 3, etc., on each tooth, the sliding and rolling between the faces can be followed. For example, in Fig. 1 the distance between the points 1 and 2 on the pinion tooth is very short, while on the gear tooth it is comparatively long. The difference in length between these points on the two teeth is a measure of the sliding which will occur during action between these portions of the tooth profiles. The shorter distance represents the distance of the rolling contact. These measures so obtained are shown enlarged on the scale below the diagram; the same procedure has been followed in Fig. 2. The advantage of choosing a pressure angle and pitch circle position relative to the teeth, to suit the gears, is at once apparent. By maintaining a standard 14½-degree pressure angle and keeping to standard tooth proportions as in Fig. 1, about two-thirds of the tooth flank is useless, and the wear on the part that is used is increased proportionately. The sliding contact is reduced in Fig. 2 by about 11 per cent, and the rolling contact increased by about 75 per cent, while the thickness of the teeth at the root is as about 1.3 to 1 as compared with that in Fig. 1.

It has sometimes been the practice to improve pinions with a small number of teeth by keeping the pressure angle at 14½ degrees, and increasing the addendum and correspondingly decreasing the addendum of the gear, the dedenda being modified accordingly. With large gears and small pinions the results are not unsatisfactory, but such a compromise is of decreasing value as the number of teeth of the gears becomes less than about 40, since the improvement of the pinion is made at the expense of the gear teeth.

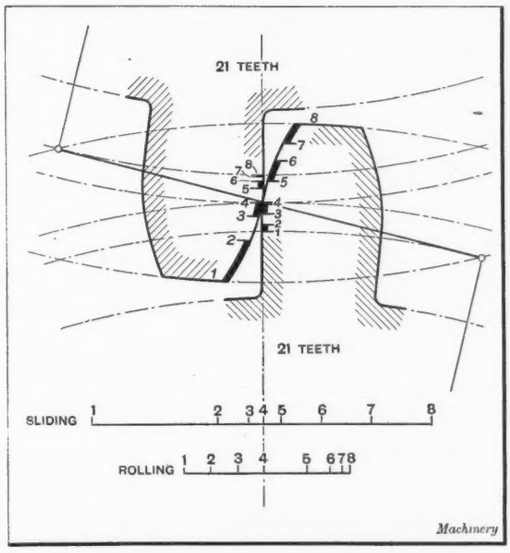


Fig. 3. Comparison of Sliding and Rolling Contact on Two Gears having 21 Teeth and 14½-degree Pressure Angle

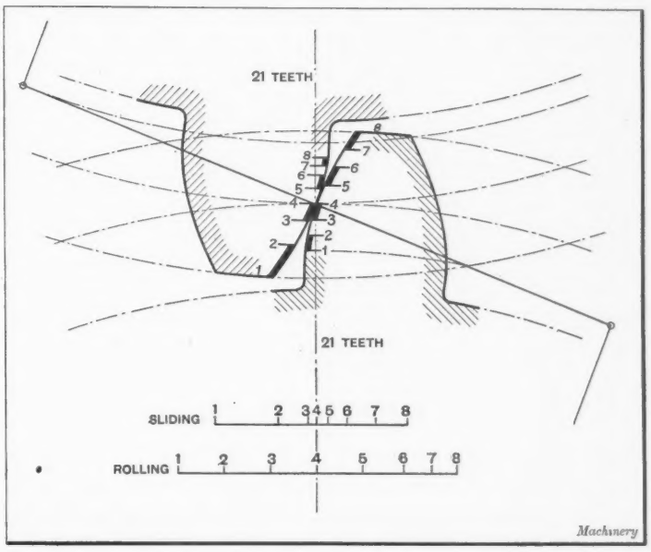


Fig. 4. Profiles of Teeth of Two Gears of the Same Ratio as those in Fig. 3, but with a Pressure Angle of 21 Degrees 44 Minutes

Another interesting gear ratio is 21 to 21; Figs. 3 and 4 show the teeth for gears of this ratio and pressure angles of 14½ degrees and 21 degrees 44 minutes, respectively. By following the same procedure as in Figs. 1 and 2, the comparison has again been made between sliding and rolling contact. The useless radial portions of the tooth flanks are again evident, and a comparison of the distances between points 1 to 2 on each is striking. The improvement following the adoption of a pressure angle and tooth proportions better suited to the gear ratio is evident as regards tooth shape, active profile, and proportion of rolling to sliding contact. As a further illustration, Fig. 5 shows the teeth for gears having a 5 to 50 ratio and a pressure angle and tooth proportions chosen to obtain the most satisfactory pair possible. While these teeth are kinematically correct, of ample strength, and have good wearing qualities, they represent an extreme case and are not to be recommended except where necessary to meet some unusual condition.

Principles of the Maag Gear System

One of the main arguments advanced in the early days of the involute gear was that a pressure angle of 14½ degrees meant a considerable increase in the force tending to separate the bearings of mating gears, and no doubt this fear was at the root of the failure to take full advantage of the properties of the involute for gear teeth. In the system

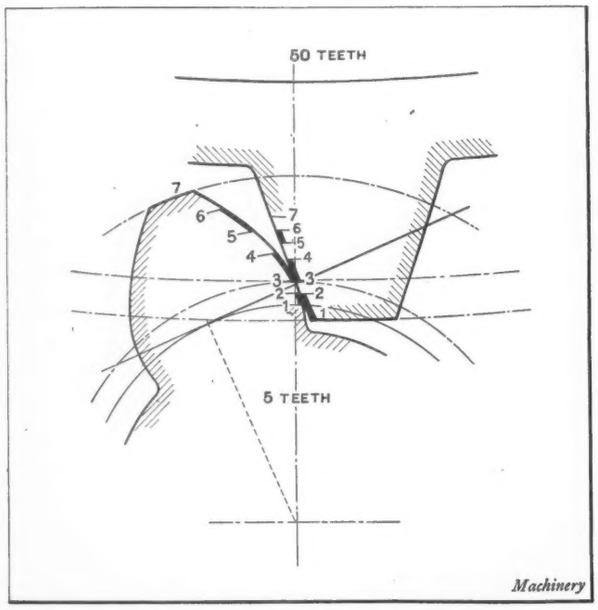


Fig. 5. Teeth of Gears of a 50 to 5 Ratio, with Pressure Angle and Proportions chosen to obtain the Most Satisfactory Combination

developed by Max Maag, Zurich, Switzerland, all standards for pitches, relations between addenda and dedenda and pressure angles are subsidiary, that is to say, each ratio is treated on its merits, and any pitches are therefore possible. Although the smallest number of teeth calls for pressure angles of 25 degrees if satisfactory teeth are to be obtained, this only means an increase of 6.6 per cent in the tooth pressure, while in less extreme cases where a pressure angle of, say, 20 degrees meets the requirements, the increase in the tooth pressure is only 2.7 per cent.

The increases in tooth pressure are, of course, inversely proportional to the cosines of the pressure angles. As far as the bearing load is concerned, it is claimed that although, for a pressure angle of 20 degrees, the pressure component in line with the two centers is increased 32 per cent, the increase being proportional to the sine of the angle, this involves no extra pressure on the bearings, since the same resultant pressure has to be sustained in any case. Any pair of components giving this resultant pressure will have the same effect, the only difference being one of direction. The increased tooth pressure amounting to 6.6 per cent for a 25-degree pressure angle is, therefore, the only increase of load on the bearings, while the advantage of really efficient gears having a small number of teeth may be considered to outweigh fully any disadvantage on this score. The independence of the center distance between gears having involute teeth overcomes the seeming complexity of a large number of arbitrary pressure angles. Neither need there be any clinging to well-defined pitches, and a designer can fix his center distances and pitches strictly as called for by any conditions that arise in the designing stage.

Using Standard 14½-degree Rack Cutters

If a pair of gears of a definite ratio is required and the best pressure angle and tooth addenda and dedenda have been decided upon, ignoring any standard proportions to get an efficient tooth, it is possible, within well-defined limits, by taking advantage of the properties of the involute, to cut these gears with a standard 14½-degree rack cutter. It is clear that one imaginary circle on the gear blank will be equal in circumference to the number of teeth cut multiplied by the pitch of the cutter. This imaginary circle will be the normal pitch circle for that particular rack, and no matter what depth the teeth are cut into the blank, this pitch circle will remain the same.

If this gear is mated with another produced by the same cutter, they will work correctly together at a pressure angle of 14½ degrees, if the center distance equals the sum of the halves of the pitch circle diameters. The pressure angle will vary, but the velocity ratio will be correct and uniform with any other center distance at which the teeth will mesh. This may have the effect of producing backlash if the teeth have been cut to the standard depth, but if the degree to which the gears are to be separated is known, the cutter can be fed to a lesser depth in one or both gears just sufficiently to prevent backlash, and the gears will have different pitch circles and a new pressure angle.

Working backward, the position relative to the teeth at which the pitch point is to occur can thus be determined, and also the outside diameters and the radii of the base circles. The position along the profile where the 14½-degree rack tooth flank will be tangent can be calculated, this point giving the radius of the normal pitch circle for cutting with the 14½-degree rack cutter. In this or any other rack system of gear cutting, it is possible, in general practice, to use only a stepped series of pitches. The teeth of the gears must be such that the involutes cut the pitch circle for a pressure angle of 14½ degrees, at points, the distances between which correspond to a circumferential pitch equal to the linear pitch of the rack cutter available.

There can be no doubt that the involute without corrections or under-cut of any kind is the right line of development for gears. Under the Maag system, in the case of pinions having small numbers of teeth, the so-called pressure angle and the fixed position of the pitch circle relative to the teeth, are abandoned. However, a 15-degree pressure angle is maintained for gears with a large number of teeth, the angle being increased and the blank diameters varied as required to obtain the most satisfactory teeth that can be obtained for gears with a smaller number of teeth.

The Maag Gear Generating Machine

A Maag gear generating machine for cutting gears up to 40 inches in diameter is illustrated in Fig. 7. A rack type tool cuts on the down stroke, being backed by a spring-tempered plate, which enables the tool to be used even when thin from repeated grindings. The faces of the rack-cutting teeth are ground concave to give a small amount of top rake to the cutting edges. The tool-holder is pivoted horizontally

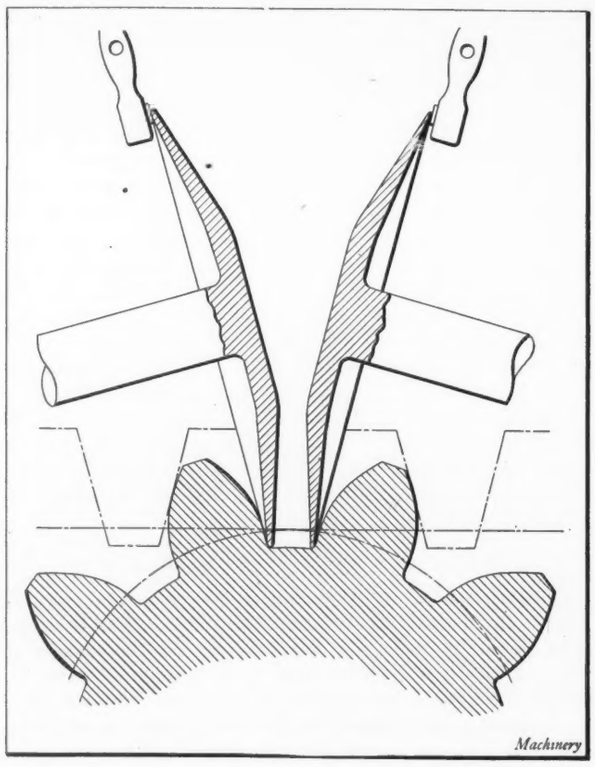


Fig. 6. Operating Principle of the Maag Gear-grinding Machine

in the ram, the tool being depressed positively at the end of each downward stroke, to provide clearance on the upward stroke. The blank remains stationary during the cutting stroke, and the indexing movement takes place during the return stroke. The cutter-head can be swiveled to cut helical gears, the setting being determined by means of a vernier scale which indicates readings to within 1 minute. The ram is driven by a slotted link giving a quick return. The stroke can be adjusted by a handwheel from the rear, and this can be done while the machine is running. The ram is counterbalanced, and the connecting-rod driving the ram is in two parts which are connected by a cast-iron sleeve that acts as a safety device, breaking if overloading occurs. The drive is controlled by a cam clutch which is connected with a brake, so that the movement of the tool can be controlled and stopped at any position.

In the generating movement given to the gear blank, the rotary motion is obtained through a worm, and the transverse motion through a feed-screw. The blank is set at the required position relative to the cutter, which always cuts at the full tooth depth, the generating cut being preceded by gashing. The setting is read on a scale and vernier. Fig. 8 shows a rear view of the machine. Several sizes of the machine are made, including those for the large gears used in turbo-reductions. In this country the Niles-Bement-Pond Co. is building a machine for cutting spur, helical, or herringbone gears up to 40 inches in diameter.

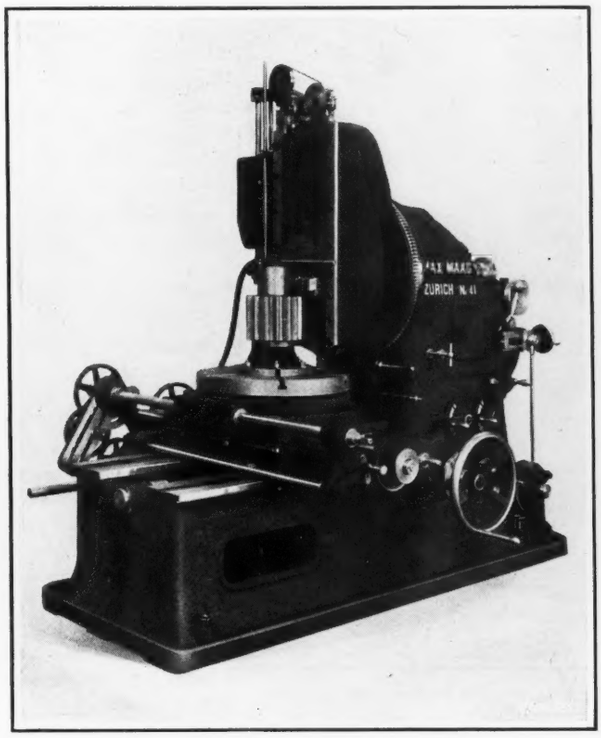


Fig. 7. Maag Gear Generating Machine provided with a Rack Cutter that cuts on the Down Stroke

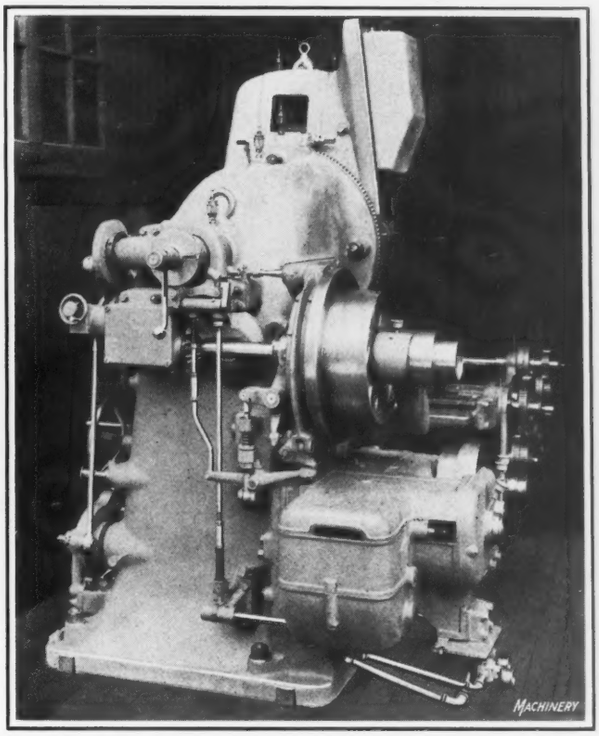


Fig. 8. Rear View of the Maag Gear Generating Machine illustrated in Fig. 7

Operating Principle of Maag Gear Grinding Machine

The distortion which occurs in hardening has a decided effect upon the efficient working of gears. It is useless to pay considerable attention to the cutting of accurate tooth profiles concentrically arranged around a center if the tooth conditions are upset in the subsequent hardening. The distortion produced in hardening Maag gears is corrected by grinding on a specially developed machine, the principle of which is shown diagrammatically in Fig. 6.

The problem in developing this machine was to secure a movement of grinding wheel faces in true planes parallel to the gear axis, the planes to include the profile of the rack tooth flank. The flat face of a grinding wheel has disadvantages, since the plane surface is quickly destroyed. This difficulty was overcome by the use of saucer-shaped wheels of which only the edges lie in the plane referred to. Generation is effected by feeding the gear tooth space under a pair of such wheels, the gear at the same time being rolled alternately in each direction an amount sufficient to generate to the full extent the involute required for the teeth profiles. The wheel edges are generally set 15 degrees from the vertical. When the teeth are small, both wheels cannot occupy the same tooth space, and so in such cases one wheel operates on the corresponding flank in the next space or the next space but one.

As the wheel wears, which is likely to take place quickly owing to the small area in contact, especially if soft wheels are used, the planes come nearer together and the teeth would become thicker as the work proceeded, if a remarkably effective compensating device were not provided. Near the upper edge of each wheel is a pivoted arm carrying a flat ground diamond. Every six seconds or so the diamonds are allowed to advance to the edges of the rotating grinding wheels. If the edge is still in the predetermined plane, the diamond touches the wheel and the lever is held up at this point. However, if the wheel has worn slightly, the diamond must advance further to touch the edge, and in so doing an electrical contact is made, and the wheels are fed outward 0.001 millimeter (four hundred-thousandths inch). It is claimed that the wheel edges are kept to the required plane within this degree of accuracy.

Construction of Maag Gear Grinding Machine

Fig. 9 shows a Maag grinding machine for gears up to 16 inches in diameter. The grinding wheel spindles are seen at *A*, each being driven by an independent motor which, through a light belt and worm-gearing, drives continuously a camshaft that rotates and permits the advance of the diamond as explained. A quick adjustment is provided for use when setting new grinding wheels. The continued adjustment of the grinding planes enables quick-cutting soft wheels to be employed. The spindles, with their ball bearings, are self-contained in sleeves that enable them to be changed easily. The spindle slide motion and compensating

mechanism is a self-contained unit that can be swiveled to give the equivalent of a rack of any pressure angle. The units are carried on horizontal slides independently adjustable for setting the width of the ground tooth space, and the depth of tooth is set by the handwheel at the top of the machine, vernier scales showing the position accurately in each case. It is also possible to adjust vertically to enable different sizes of wheels to be used together. A diamond dressing attachment *C* enables both wheels to be dressed accurately as to height when the vertical scale reads zero.

The work carriage has a dead center at its inner end, and an automatic dividing head at its outer end. In addition to the movement for one passage from end to end of each tooth space under the grinding wheels, the carriage has to make several short cross traverses to supply the rolling movement to the work for generating the involute profiles. The bottom slide, with the work, is fed under the grinding wheels by a screw, the travel being adjustable according to the width of the work. The upper or rolling slide also has a variable stroke, and is driven by a slotted crank disk arranged horizontally at the far side of the machine.

The dividing spindle, which also carries the work, is mounted on the upper slide carrying the division plate, while the locking pawl that engages with the plate is carried by the aluminum circular housing *D*, which is mounted on a sleeve or outer spindle surrounding the dividing spindle. On the outer end of this sleeve are mounted four segmental blocks of equal diameter. Nine sets of these blocks are provided, corresponding to nine convenient pitch diameters. Four steel ribbons wrap around the circumferential parts of the segments, two passing to one side of the machine and two to the other, the free ends being secured at points *E*. The securing blocks are carried in a frame *F*, and can be partially rotated to adjust the ribbons by means of the heads *H*. The frame can be raised or lowered on vertical slides so as to bring the ribbons in a horizontal position for various segmental block sizes.

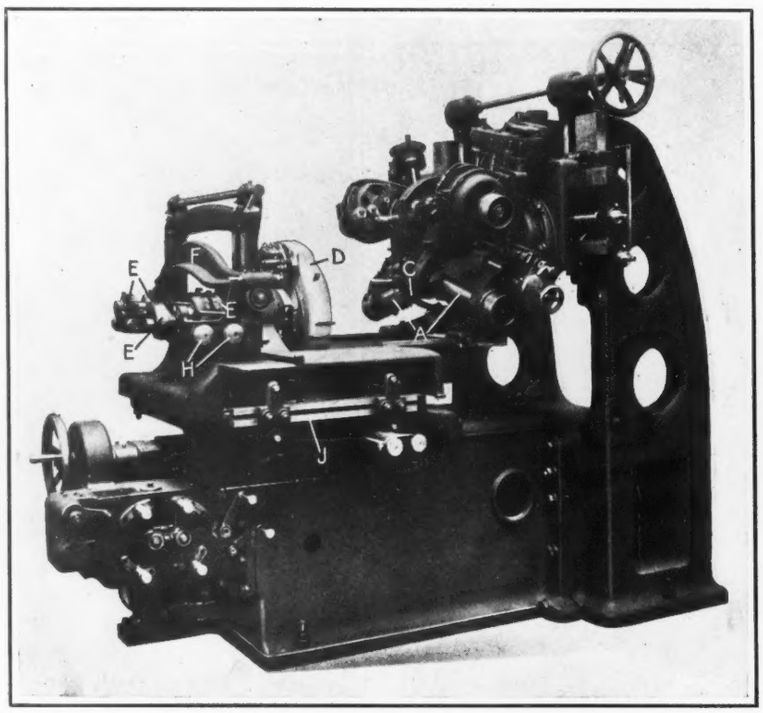


Fig. 9. Grinding Machine with Two Wheels used for grinding Profiles of Maag Gears

If the wheel being ground has an imaginary pitch diameter corresponding exactly to the segmental ribbon blocks in use, the work-slide is reciprocated during the traverses under the grinding wheels and the ribbon frame carrying blocks *E* remains fixed. A to-and-fro rolling motion along the pitch circle is thus given to the work. If the nominal pitch circle of the gear is not equivalent to that of an available set of segmental blocks, the ribbon carriage is also given a reciprocating movement that compensates exactly for the difference in pitch diameter, and this is originated by the cross-slide. The movement is transmitted by the slotted bar *J*, which rocks on a vertical axis that can be altered to vary the ratio of the two arms of the rocking bar.

The travel forward of the work during each short rolling motion is dependent on the finish required, 1/32 inch being suitable for a medium sized tooth when finish-grinding. Grinding takes place during both the in and the out travel of the main slide, and indexing occurs when the wheels are clear at either end. A pinion on which the teeth were ground on a Maag grinding machine is shown in the heading illustration. The hatched effect given to the teeth by the grinding wheels is very noticeable. When an indexing is to occur, the feed of the main slide is stopped and the position maintained by a solenoid lock. The gear-box, from which the slides are driven, is seen at the extreme outer end of the bed. The main driving motor is placed behind the gear-box, which it drives through worm-gearing. Four speeds are provided for the rolling slide, and four for the feed-slide.

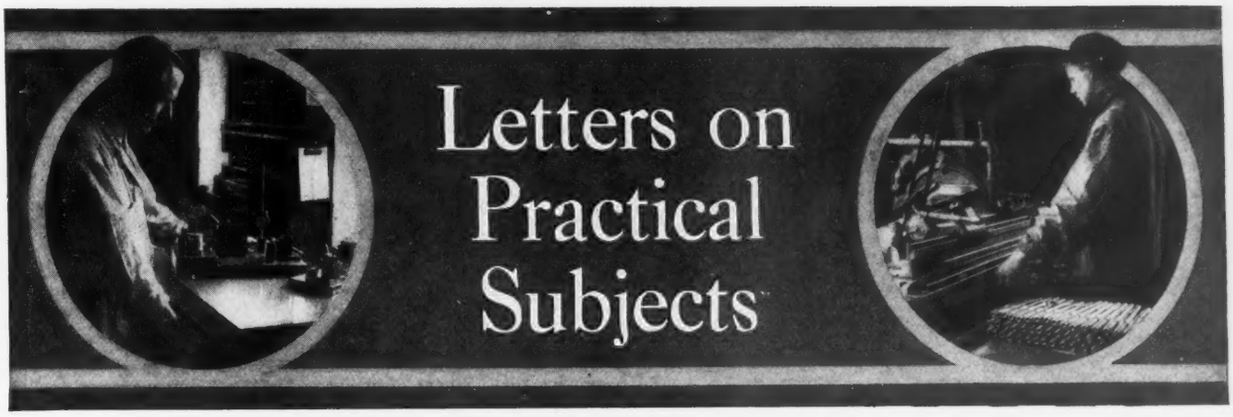
Applications of Maag Gears

Hardened and ground gears produced on Maag machines and designed without regard to standard pressure angles are in fairly extensive use. This is especially the case in Switzerland, where the state railways use them for motor drives on 2000- and 2500-horsepower electric locomotives. They are used almost exclusively on street-car motor drives in that country. In turbine reductions there are several instances in which double helical gearing has been superseded by straight-cut Maag gears, the pinions being hardened and ground. It is claimed that since the grinding operation produces a true tooth form and concentricity, the pinion acts as a master to the softer teeth on the gear, which are thus burnished and any irregularities corrected. In several turbine installations the gears run silently at the high peripheral speed of 13,400 feet per minute with no other lubrication than that supplied by leakage from bearings. The Niles-Bement-Pond Co. has the exclusive American rights to the manufacture of Maag gears. The Pond Works, Plainfield, N. J., have cut gears up to 80 inches in diameter, while the Pratt & Whitney Co., Hartford, Conn., has cut and ground gears up to 16 inches in diameter.

* * *

INDUSTRIAL CONDITIONS IN SWEDEN

The difficulties at the present time experienced by the Swedish industries were first felt in the metal and machine industries as early as 1919, but the depression did not become particularly acute until the last months of 1920. Out of the 120 blast furnaces in Sweden, only 42 were active in December, 1920, and the production of iron and steel was lower than for a great many years past. During the latter part of 1920, Germany offered severe competition, quoting prices in the Swedish markets lower than the bare cost of labor and materials in Sweden. Wages in Sweden are now three times as high as before the war, and the labor efficiency less, so that the actual labor cost per unit of production is four times as high.

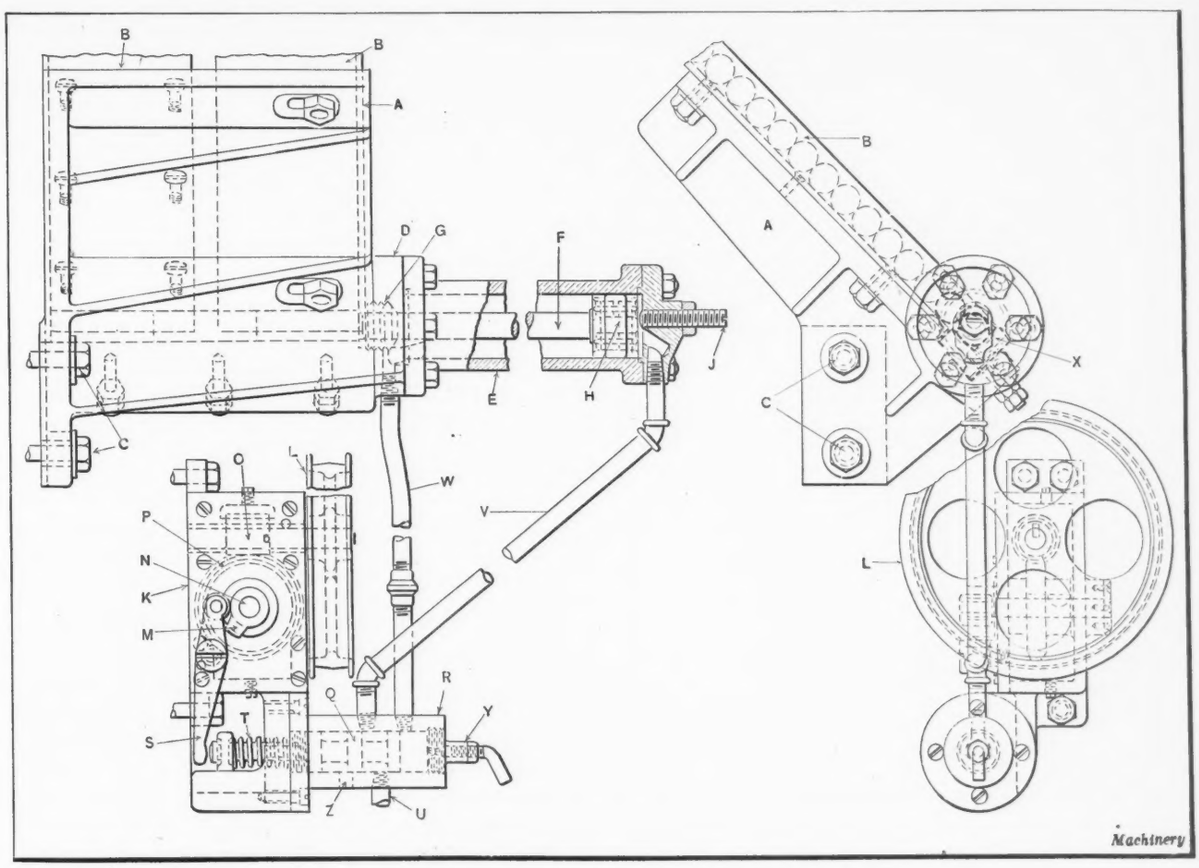


PNEUMATIC FEEDING ATTACHMENT FOR CENTERLESS GRINDER

The accompanying illustration shows a feeding attachment which has been successfully applied to a centerless grinder of the Detroit Tool Co.'s manufacture. This device is designed to handle rolls and pins of various diameters and lengths, the range of adjustment making it particularly well adapted for use in grinding parts employed in automobile construction, such as engine wrist-pins, valve rollers, etc. In designing this attachment, the writer was handicapped by lack of space around the grinder. This necessitated the use of a compact fixture, the stroke of which could be controlled without cumbersome and expensive mechanisms. Reference to the illustration will show that the feeder is operated by air, and is so designed that it can be easily controlled by an inexperienced operator. The advantages of a pneumatic device of this nature are: The ease with which the length of stroke can be adjusted; the adjustable slow feeding feature; and the rapid return movement of the feeding plunger.

It will be noted that the cast-iron slide *A* is provided with elongated bolt holes to permit the adjustment of the sheet-metal sides *B* to accommodate rollers or pins of different lengths. The slide can be made as long as desired and adapted for holding any length of work within the capacity of the feeding mechanism. The chute is bolted to the grinding block of the machine by means of bolts *C*. A flange *D*, cast integral with the chute, carries a bronze cylinder *E* fitted with a piston-rod *F*, a suitable packing-box *G*, and a properly packed piston *H*. The length of the stroke is adjusted by the headless set-screw *J*.

A small gear-box *K* is bolted to the side of the grinder. The pulley *L* of this gear-box is driven by a belt from the lineshaft or a countershaft. A cam *M* keyed to the worm-wheel shaft *N*, which is driven by worm *O* and worm-wheel *P*, actuates the plunger valve *Q* in the bronze cylinder *R* through the medium of lever *S* and spring *T*. The speed of the gear-box pulley *L* controls the number of strokes per minute of the feeding rod *F*. The point at which the air supply pipe *U* enters the cylinder *R* must be carefully located, that is, it must be correctly positioned with respect



Air-operated Feeding Attachment for Centerless Grinding Machine

to the bored holes which lead through pipes *W* and *V* to and from cylinder *E*. In the illustration the plunger valve *Q* is shown in such a position that the air will travel up pipe *V* and enter cylinder *E* at its outer end. The air entering at this end of the cylinder, forces the piston *H* inward against the resistance of the air in the opposite end of the cylinder. The air thus forced down the vertical pipe *W* enters the outer end of cylinder *R* where it escapes through a small needle valve at *Y*.

A moderately fast or a very slow stroke of the feed-rod can be obtained by adjusting valve *Y*. When the valve is so adjusted as to permit the air to escape slowly from the inner end of cylinder *E*, the feed-rod *F* will move forward slowly, while if the valve is opened to permit the air to escape more rapidly, the feed will be faster. The return of piston *H* is accomplished when the valve *Q*, actuated by cam *M*, simultaneously opens exhaust port *Z* and the inlet port of pipe *W*. With the valve in the latter position, the air is quickly exhausted from one end of the cylinder through pipe *V* and opening *Z* while the air from the feed-pipe *W*, acting on the inner side of piston *H*, forces the latter quickly toward the outer end of the cylinder until it reaches the position shown in the illustration. When plunger *F* reaches the end of its outward stroke, a roll or pin, as the case may be, drops down by gravity into the feeding position, when it is carried forward into contact with the grinding wheel by the slow-feed stroke. The operation of the device is therefore automatic and continues as long as the feed-slide is supplied with work. The V-shaped block *X* is so designed that it is possible to adjust it in order to bring work of different diameters into the proper feeding position.

Rochester, N. Y. A. H. SCHWAB

SELF-ADJUSTING LATHE DOG

In a large factory devoted to the manufacture of textile machinery considerable difficulty was experienced in turning cast-iron drums for carding machines. These drums consist of a cast-iron cylinder of the shape shown in Fig. 1, and are about 5 feet long and 4 feet in diameter. At each end is a central hub supported by a set of six arms or spokes. When assembled in the carding machines and in operation, these drums maintain a relatively high surface speed. As no heavy loads are applied to them, it is desirable that they be of light weight construction.

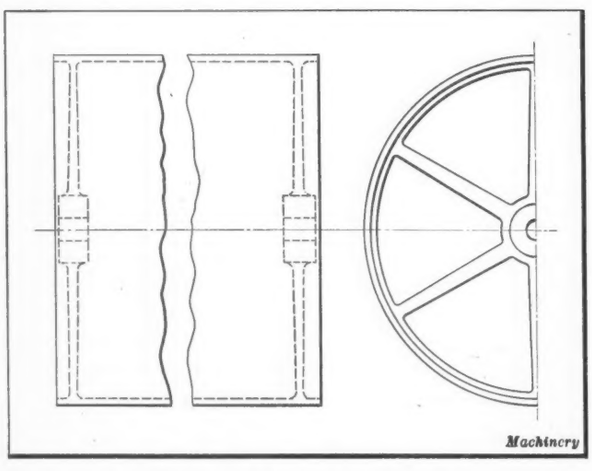


Fig. 1. Cast-iron Drum used in Textile Machine

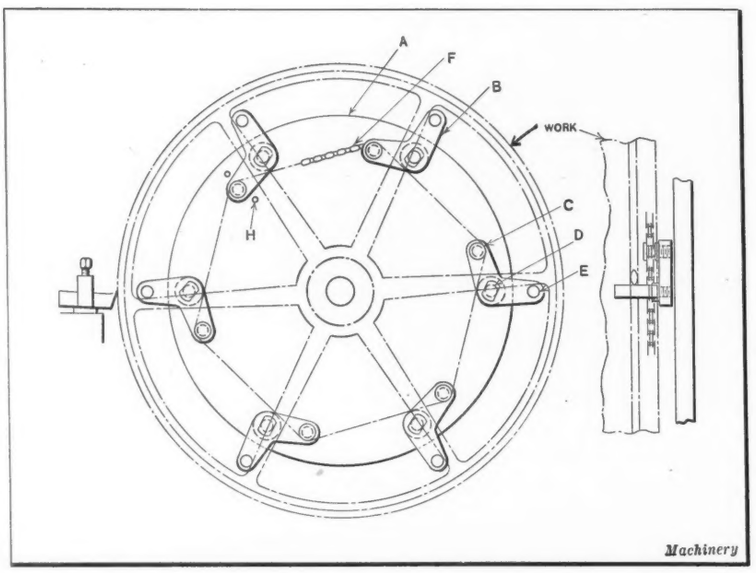


Fig. 2. System of Multiple Dogs for Lathe used in turning Drum shown in Fig. 1

While lightness is an advantage so far as the functioning of the drums in the carding machine is concerned it proved a drawback from the manufacturing point of view. When properly centered in the lathe, the outer surface is turned down to finish, and on account of the large dimensions a considerable amount of stock must be removed to give a clean surface all over. It often happens that some portions of the middle part of the rough casting will run out ⅜ inch or more, and it is a slow job to finish even the best castings.

A light cut and slow feed must be applied; otherwise the spoke in contact with the lathe dog will break off, thus ruining the drum. As it was impossible to have more than one fixed driving point, a system of self-adjusting multiple driving dogs was tried out which proved very satisfactory. The construction of this device is shown in Fig. 2. In this illustration *A* represents the lathe faceplate and *B* the main part of one of the six driving dogs. These dogs are made of cast iron of suitable dimensions and of approximately the form shown in the illustration. They swivel on a stud *D* fastened to the faceplate.

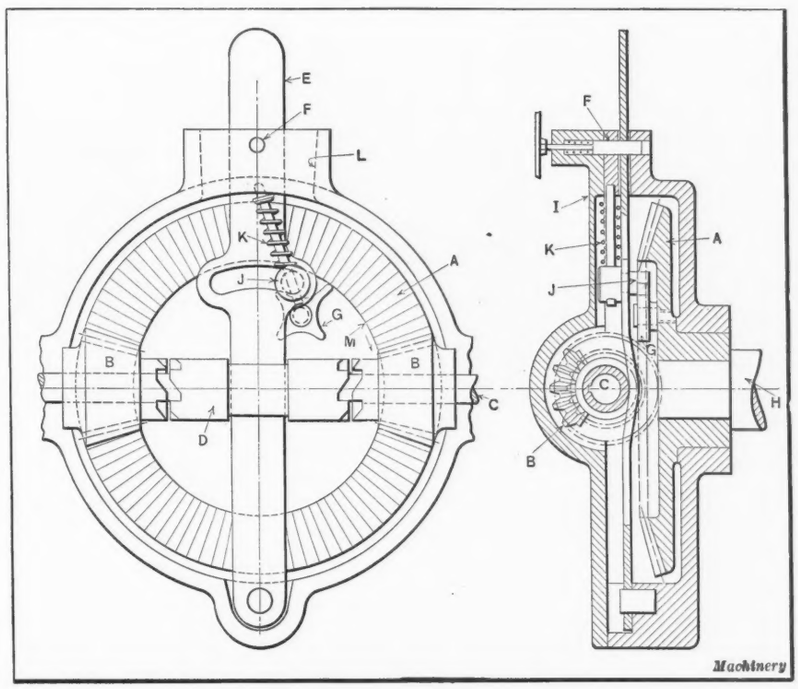
At *E* is shown one of the driving studs which make contact with the arms or spokes of the drum. There are also six studs *C* which are provided with flanges and which carry an endless block chain *F*. The six dogs are fastened at the proper distance and spaced 60 degrees apart. The chain is of suitable length and allows each driving pin to exert the same power on each spoke. Twelve pins *H*, only two of which are shown, are driven into the faceplate to prevent undue movement of the parts when idle.

With the drum in place and the lathe started, each of the six dogs will drive its respective spoke with an equal driving force. By this method of driving, a deeper cut and a higher feed are used, and the breakage is reduced to practically nothing, which results in a greater output.

New York City C. G. YOUNGQUIST

A RECIPROCATING MECHANICAL MOVEMENT

The type of mechanical device described and illustrated in this article is used for producing the reciprocating motion of a washing machine. The device is compact, and has but few parts to require attention. The working parts are contained in an enclosed case, which may be cast from any suitable material and which is provided with a cover *I*, attached to the case in any convenient manner. The working parts consist of a bevel gear *A* with which two bevel



Mechanism for producing a Reversal of Rotary Motion

pinions *B* mesh. These are a running fit on the shaft *C*, and should be provided with phosphor-bronze bushings and backed with a substantial flange or end thrust bearings. The construction shown in the illustration, however, does not show these features.

The purpose of the mechanism is to reverse the rotation of shaft *H* to which the bevel gear *A* is attached. This is accomplished by means of a sliding jaw clutch *D*, which operates on a sliding key carried on shaft *C*. The sliding member of this clutch is necked at the center, the width of the neck being such as to accommodate the width of the operating lever *E*, which bears against it from beneath. The operating lever fulcrums on an ordinary steel pin, and this movement slides the clutch *D* sufficiently to alternately engage and disengage the clutch teeth which are an integral part of each pinion *B*. These alternations of movement are accomplished by star-wheel *G*, which is made of casehardened machine steel. The star-wheel operates on a stud which screws into the body of the bevel gear. It is important that the star-wheel be securely attached to the gear, because if it becomes loose the operation of the mechanism will fail. The operating lever *E* is held in a neutral position by a spring plunger *F*, which extends through the cover of the case and is operated by a knob. There is a hardened steel stud *J* which operates in a circular slot in the operating lever and is held in contact with the end of this slot by the tension exerted by spring *K*. This spring is carried by a long pin, the opposite end of which is pivotally fastened to the gear *A*.

In order to more thoroughly understand the operation of the mechanism, the method by which the reversal of rotation is accomplished will be described. Assuming that the motor which drives the shaft *C* is in operation, the stop-pin *F* is pulled out and given a quarter turn to lock it in its raised position until the mechanism is again brought into a neutral position. The stop-pin releases the clutch-operating lever *E* which, owing to the tension exerted by spring *K*, is forced to the right until it is brought up against surface *L*. This engages the right-hand bevel pinion clutch and drives the gear in the direction indicated by the arrow. Each revolution of the bevel gear brings one point of the star-wheel *G* into contact with stud *J*, resulting in rotating the star-wheel a quarter turn with each revolution of the bevel gear. On the fifth revolution of the gear, the long arm of the star-wheel becomes wedged against surface *M* of the bevel gear, so that as the gear continues to revolve, the stud *J* will be swung over to the opposite side of the slot in which it operates, thus disengaging the right-hand clutch and engaging the clutch which operates the left-hand pinion. This results in reversing the motion of the machine during another five revolutions of the gear, at which time the transfer movement again occurs, and this sequence of mechanical movements continues until the machine is placed, manually, in a neutral position by again engaging the spring-pin *F*. It is important to remember that the number of revolutions before reversing the direction of rotation is governed entirely by the number of arms on star-wheel *G*, there being one more revolution required to reverse the shaft *H* than there are arms on the star-wheel. The length of the odd point of the star-wheel must be such as to just bind against surface *M*.

Cleveland, Ohio C. F. GEORGE

MILLING AND GRINDING HELICAL OR SPIRAL CAMS

The face or helical cam shown in the accompanying illustration at *A* is required to have a fairly accurate helix face, with a rise or pitch of ½ inch in 350 degrees. This cam is made from an iron casting about 6 inches in diameter. In milling the face, the blank was mounted on the arbor of the indexing head of a universal milling machine, as shown. A 1½-inch end-mill *B* mounted in the main spindle was used to mill the helical surface. By tilting the head the amount of rise or lead of the spiral, or helix, can be changed considerably from what it would be if the dividing head spindle were parallel with the surface of the milling machine table. If the lead obtained with the spindle of the dividing head set parallel with the surface of the milling machine table were 1 inch, the lead would be approximately 11/16 inch with the spindle of the dividing head set at an angle of 45 degrees as shown in the illustration. With the head set vertically, the lead would be zero, as the cutter would simply pass over the work.

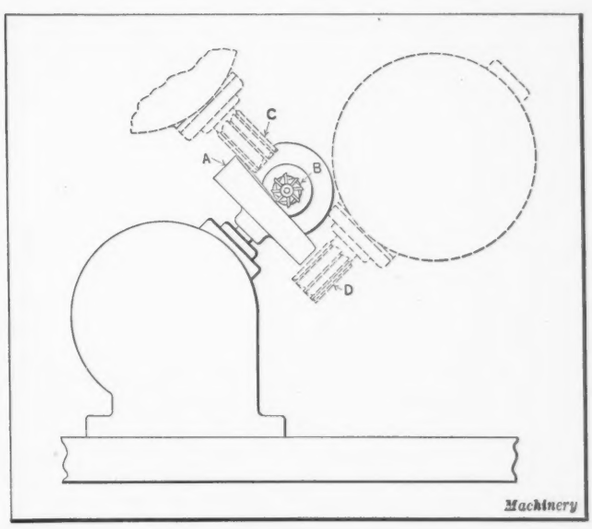


Diagram indicating Positions of Cutters for milling Helical and Spiral Cams

The helix generated by setting the head at an angle of 45 degrees was not strictly accurate, but it was sufficiently so in this case to meet the requirements. When greater accuracy is required, a vertical milling attachment can be used with the milling cutter set as indicated by the dotted lines at *C* for milling the face cam, and as at *D* for a plate or spiral cam. In setting up the milling machine for milling cams of the kind described, the machine is first geared to cut a spiral which is nearest the desired pitch or lead that can be attained with the available gearing. The dividing head is then set at the angle required to give exactly the desired result. The writer knows of no better way of setting the dividing head to the required angle than the trial method. By this method the high and low points are located, and an indicator is attached to the spindle in place of the milling cutter. The head is adjusted until the indicator registers zero at both points. The milling operation can then be performed with the assurance that the required lead or rise in the cam surface will be obtained. If it is desired to grind hardened steel cams, a portable electric grinder can, of course, be mounted on the milling machine spindle in place of the milling cutter.

Providence, R. I. JOHN T. SLOCOMB

USING A PUNCH PRESS FOR MILLING MACHINE WORK

The illustration Fig. 1 shows a tube connection used on an air-testing device. This part is made from a hard brass composition. The view at the left shows the condition of the work as it comes from the automatic machine. To finish

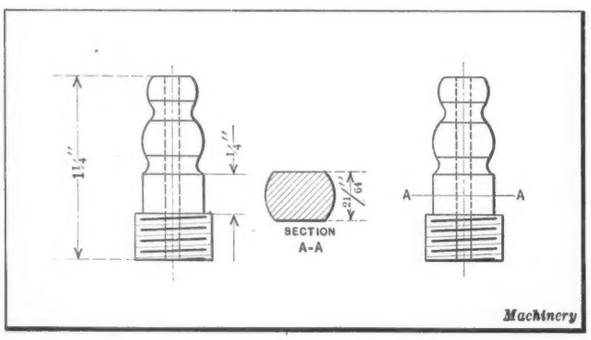


Fig. 1. Tube Connection requiring Machined Flats at Section A–A

the work, it is necessary to machine two flats on the shank as illustrated by the right-hand view and also by the section *A–A*. At first sight this looks like a milling machine job, but the only manner in which the flats could be milled with the milling machines available was to locate the work in a horizontal position using a side milling cutter, and then turn the piece 180 degrees and machine the other face; or else to place the piece in a vertical position and use an end-mill, which would also necessitate indexing the work after taking a cut on one side. Even the use of a special fixture to hold a number of the parts would not greatly facilitate production, as time would be required to place the work in the fixture and turn or index each piece in order to machine both flats.

This problem was solved by equipping a punch press for the job, the tools employed being shown in Fig. 2. The piece is placed in the die with its threaded end resting against stop-pin *A*, being located in the threads in the die which are cut to the same diameter and pitch as those on the work. The other end rests in the concave surface *B*, which has a radius equal to that of the larger spherical section of the part. The die is held rigidly in the bolster of the punch press. The punch *D* is made with two cutting edges. The space between the cutting surfaces is the width of the flattened portion of the part, or 21/64 inch.

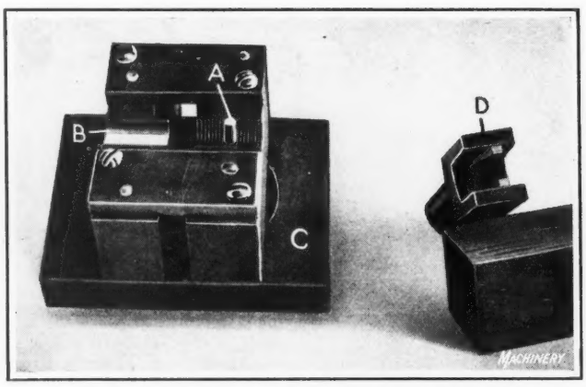


Fig. 2. Punch and Work-holding Block for machining Flats on Part shown in Fig. 1

In operation, the punch is held in the press by means of the shank, which fits the ram, and as it is forced down the two cutting edges shear away the material of the part to the correct width. The work is thus not only machined to the correct size, but owing to the knife-like cutting action of the punch it also has a smooth finish, and the production is far in advance of anything that could be expected from the use of a milling machine for this particular job.

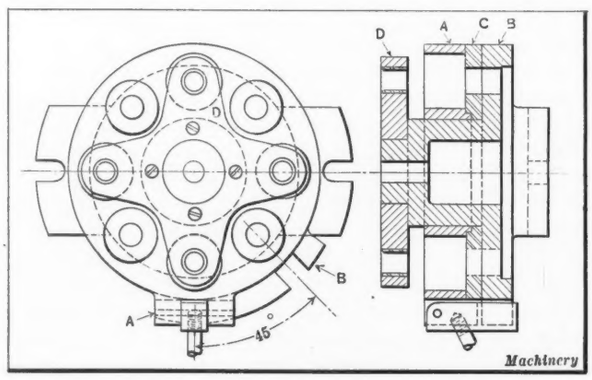
BERT TOWLER

CONTINUOUS DRILL JIG

The accompanying illustration shows the design of a continuous drill jig for use in drilling four cast-iron pinions at one time. This jig was made to be used with a four-spindle multiple drilling head, but can, of course, be employed with any multiple drilling head having spindles adjustable to the holes or bushings in plate *D*. The work-holding plate *A*, having eight equally spaced pockets, is indexed 45 degrees back and forth around the central part of jig body *B*. The latch attached to plate *A*, acting as a handle, is dropped into either slot on the projecting lug on the side of body *B*. Plate *C* is fastened to work-holding plate *A* and prevents the work from dropping through. Parts *A* and *C* can be made in one piece, if desired.

The bushing plate *D* is secured to the body of the jig in such a position that the drills are in line with one set of holes when the latch is in either slot. The pinions are prevented from turning by means of one or two teeth inserted in each pocket. It is advisable to provide feet on the jig in order to facilitate cleaning out the chips and also to give the drills sufficient room to pass through. When operating the jig, it is simply necessary to remove the four finished pinions and replace them with new ones while the four others are being drilled, then index the work-holding member *A* 45 degrees and repeat the unloading and loading of the jig.

Toronto, Canada J. J. LINTON



Continuous or Indexing Drill Jig for Use with Multiple-spindle Drilling Head

METHOD OF LOCATING TOOL WHEN CUTTING MULTIPLE THREADS

The following method of cutting multiple threads has been used successfully by the writer. First set the change-gears of the lathe to cut the required number of single threads per inch, or to give the correct lead. Then set the compound rest to the required angle (30 degrees for U. S. form threads) so that the tool can be fed to the work in the direction indicated by arrow *D* in the accompanying illustration. When one thread groove has been cut to depth, the tool is withdrawn a distance equal to dimension *A*, this distance being measured by the graduations on the dial of the compound rest feed-screw. The cross-slide is then employed to advance the tool in the direction indicated by arrow *E* until the point of the tool touches the work or has advanced a distance equal to dimension *C*.

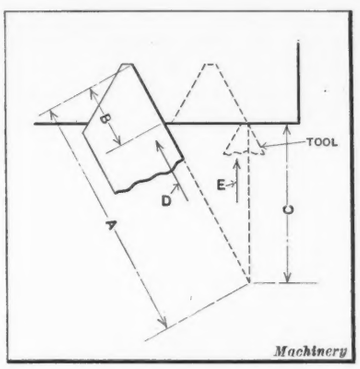


Diagram illustrating Method of setting Tool for cutting Multiple Threads

The formulas for obtaining the dimensions required in setting the tool for cutting multiple threads of U. S. form, as described, are as follows:

$A = B + \text{sec } 60 \text{ degrees} \times P = B + 2P$

$B = \text{sec } 30 \text{ degrees} \times 0.6495P = 1.1547 \times 0.6495P$

$C = \tan 60 \text{ degrees} \times P = 1.7321P$

$$P = \frac{1}{\text{number of threads per inch}} = \text{distance from center}$$

to center of thread.

For next thread proceed as before.

When using this method care should be taken to see that the compound rest is accurately set to the required angle and that the backlash in the feed-screw is taken up when using the graduated dial to set the tool. J. F. T.

[For information regarding the methods generally employed in cutting multiple threads see MACHINERY'S book "Thread Cutting Methods." This book explains how the tool may be set when cutting multiple threads (1) by indexing or turning the piece being threaded a fractional part of a revolution; (2) by setting the compound slide parallel with the screw thread being cut, so that the slide can be used for adjusting the tool; (3) by disengaging the lock-nut from the lead-screw while the lathe spindle is stationary, moving the carriage the required distance; and (4) by engaging the lead-screw at the proper time (with the lathe in motion), as shown by graduations on the thread chasing dial or indicator.—EDITOR]

REDESIGNING JOURNAL-BOX TO FACILITATE REPAIR WORK

The handling of repair work in large manufacturing plants requires considerable ingenuity and executive ability. The designer, draftsman, or shop executive, who superintends this class of work, must be able to decide quickly what parts will be required to put any broken-down machine or equipment in operation, and he must also know how to get these parts in the quickest and cheapest way.

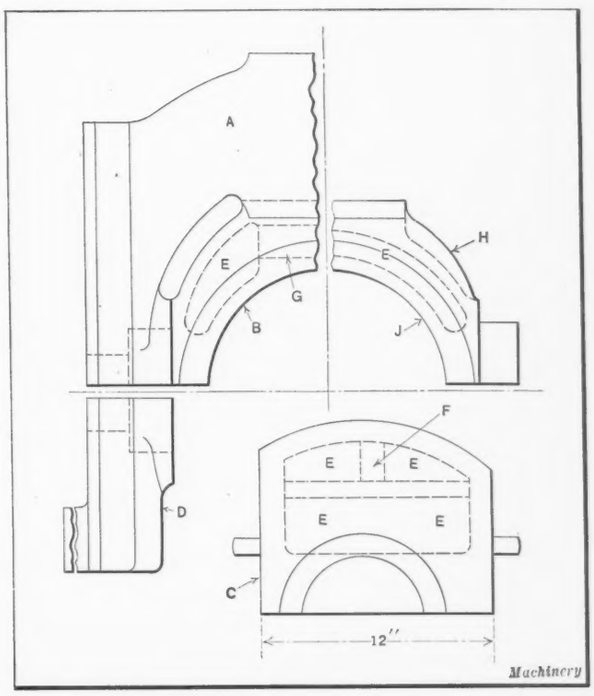
To accomplish this he will disregard all unimportant details of construction that may be incorporated in the original design, and have the repair parts made in the simplest possible manner consistent with the proper functioning of the part. The following instance serves to illustrate the importance of carefully considering the design of broken cast-iron parts when ordering new castings.

In the accompanying illustration is shown in broken sections, a water-cooled journal bearing of the saddle-trunnion type, incorporated in the design of a tilting rolling mill. The part shown at *A* is the upper trunnion slide, and the part shown at *D* is the lower trunnion slide. These slides, however, were not required to be replaced, but are merely shown to give a better idea of the relationship which the broken part bears to the complete assembly. The broken half view of the part shown at *B* indicates the shape of the upper half of the journal box as originally made. This is the part that was required to be replaced. At *C* is a side elevation of part *B*, and at *J*, a broken end elevation of the journal box as it was made to meet the requirements of a hasty repair job.

It will be noticed that the outer diameter of part *B* is oval in shape, starting with a very flat circle at the hub and ending in a circle of short radius at the "saddle." The cored water pocket *E* is made to conform to the shape of the outer surface, but where it comes next to the journal at *G* it is made flat.

This design calls for a pattern entirely shaped by hand. The middle portion of the journal box which has the greatest pressure against the neck of the roll, is solid, except for the narrow passage, and therefore derives but little benefit from the circulating water. From the illustration it is evident that the core-box for this part requires considerable labor, and that it is a somewhat difficult job for the core-maker unless he has special equipment for this class of work.

Now let the redesigned part as shown at *J* be considered. It might be mentioned here that a drawing showing every detail of the broken casting was given to the writer with instructions to have a pattern made for the part as soon as possible. After carefully studying the design, the writer



Original and Redesigned Journal-box Bearings for Rolling Mill

realized that considerable labor would be required to make the pattern according to the drawing. However, it was found that the design could be simplified without affecting in any way the proper functioning of the part. Referring to *J* it will be noted that the circles indicating the most important surfaces in the redesigned box are struck from a common center. It will also be noted that the design provides an unobstructed water-cooling chamber. The middle portion is reinforced with ribs of the shape indicated at *H*. By redesigning the part as shown, it was possible to employ the

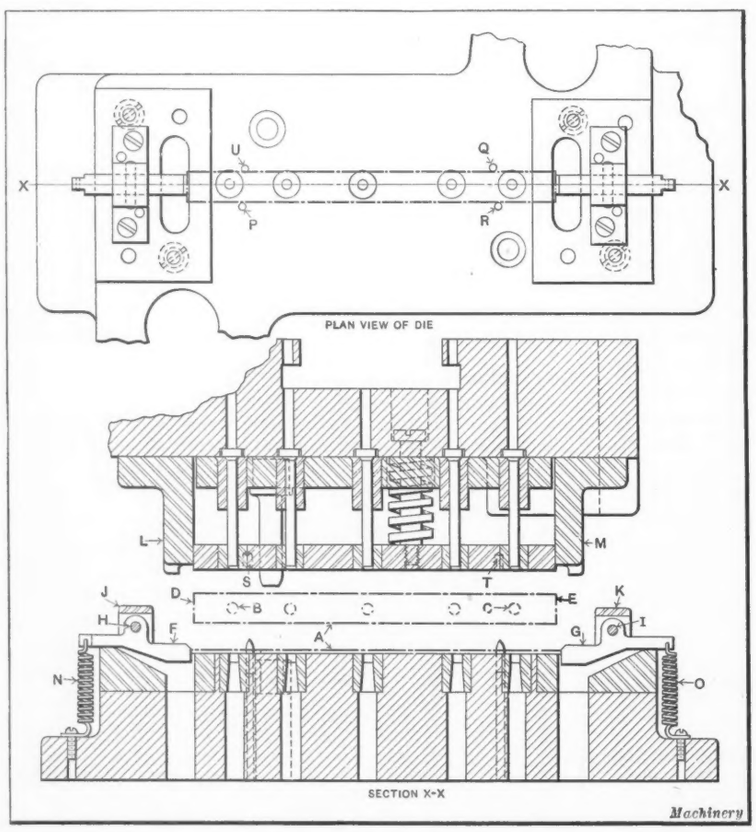
band saw in cutting and shaping practically all the pieces required in building up the pattern. Thus the pattern was made in half the time that would have been required had it been made according to the original design. The casting, as redesigned, with its large water-cooled chamber, was machined and substituted for the box shown at *B*. After a thorough trial it was found to be much more satisfactory than the one with which the machine was originally equipped.

Kenosha, Wis. M. E. DUGGAN

DISAPPEARING NESTS FOR SHAVING PUNCHES

When shaving a sheet-metal punching, the work is generally located by pilot-pins or by nest plates. As the former method is preferable, holes are occasionally punched merely to permit the use of pilot-pins in subsequent operations. When pilot-pins cannot be used, and the ends or sides to be shaved must also serve as locating surfaces, the disappearing nests described in the following may be used to advantage.

In the illustration, the work or punching *A* (a plan and side view of which are shown by heavy dot-and-dash lines) is required to have holes *B* and *C* accurately located from the ends *D* and *E* to within 0.0005 inch. Therefore, the ends were shaved and the holes pierced at the same stroke of the press. The work is located endwise by the disappearing or swinging nests *F* and *G*, which are pivoted on pins *H* and *I* to brackets *J* and *K*, respectively. Before shaving



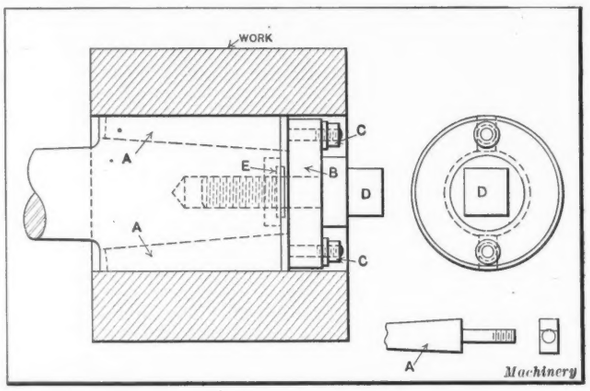
Shaving Punch equipped with Disappearing Nests

punches *L* and *M* come in contact with the ends of the work, they first hit swinging nests *F* and *G*, thus depressing the latter and bringing them out of contact with the work. On the upward or return stroke, springs *N* and *O* bring the nests back to their normal positions. The work is located sidewise by pilot-pins *U*, *P*, *Q*, and *R*. Holes *S* and *T* provide clearance for the pilot-pins that are shown at *U* and *Q*.

B. SPECTOR

FRICTION ARBOR

The special arbor here shown has several advantages over the ordinary expansion arbors generally used to hold work of the kind indicated in the illustration. The chief advantage is that it will not work out of true after being in use



Friction Arbor for Work requiring Facing and Threading Operations

for a considerable length of time, as is frequently the case with arbors having spring collets. The operation performed on the work in this particular instance consists of facing both ends and threading the outside. It is, of course, necessary, in using an arbor of this kind, to have the hole in the work finished close to size.

After the chuck is turned and finished to a good fit in the work, two taper slots are cut to take the taper keys *A*. Two holes are drilled through collar *B* as indicated, to take the shanks of keys *A*. The holes through collar *B* are slightly larger in diameter than the key shanks to allow a slight rise or fall of the keys as they slide in the tapered slots. Nuts *C* are screwed on the end of the key shanks. Screw *D* is drilled to receive a pin *E*, and the tops of keys *A* are rounded to the same radius as the body of the arbor which fits the work. When the work is slipped in position, the tightening of screw *D* against collar *B* forces the wedges out against the work. When screw *D* is loosened for the purpose of removing the work, pin *E* comes in contact with collar *B* so that the wedges are withdrawn, thus releasing the work.

HARRY MOORE

Rosemount, Montreal, Canada

* * *

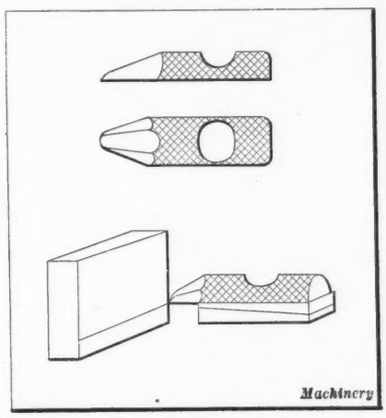
BUREAU OF INFORMATION AT WASHINGTON

On the initiative of President Harding a Bureau of Information has been established on the ground floor of the Post Office Department Building, Pennsylvania Ave. and 12th St., the purpose of which is to give as full information as possible concerning all governmental departments to those who go to Washington to transact business with any department or bureau of the Government. The Information Bureau will be able to advise the visitor as to the exact location of any particular department and the means of reaching it. Manufacturers and others having business to transact with the Government Departments in Washington are invited to make use of this facility. There is need for such an information bureau, as it is often a difficult matter to locate the department or official to be seen among the many government offices in Washington.

SHOP AND DRAFTING-ROOM KINKS

SCRIBE FOR LAY-OUT WORK

A marker or scribe for use in laying out lines a predetermined distance from the edge of angle-plates, die-blanks, etc., is shown in the accompanying illustration. This marker is made by knurling a piece of round carbon steel and then machining and filing the knurled piece to the shape shown by the two upper views in the illustration. The notch filed in the top of the knurled portion serves as a "finger-grip." After being hardened, the marker is, of course, ground flat on the bottom and to a sharp point at the end. It can be used with standard size blocks, or with adjustable parallels as indicated in the lower view.

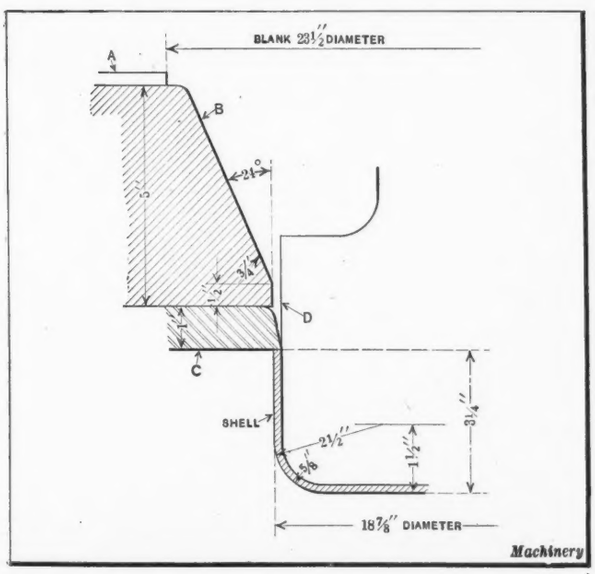


Scribe for Lay-out Work

Brooklyn, N. Y. HOWARD HOUSE

DRAWING DIE KINK

The accompanying illustration shows how a slight change in drawing die design enabled a shell to be drawn having a large radius at the bottom, which formerly had caused trouble. The die is of the push-through type, and the blank, which was 23½ inches in diameter, was located in the gage



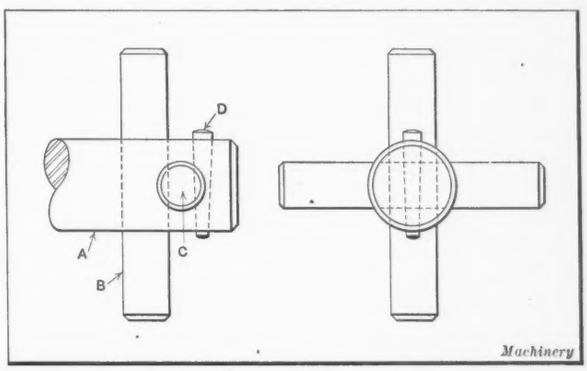
Tapered Drawing Ring for drawing a Part with a Large Radius

ring *A*. The drawing ring is shown at *B*, the stripper at *C*, and the punch at *D*. All the parts are standard construction, except the drawing ring, which is made with a 24-degree angle. By making the drawing ring with this angle, the shell was successfully drawn to the diameter and radius indicated. The stock is 5/32-inch sheet steel, and the operation was performed on a No. 78½ Bliss press.

Cleveland, Ohio D. C. OVIATT

SECURING TWO RODS AT RIGHT ANGLES

In the accompanying illustration is shown a method devised by the writer for rigidly securing two rods at right angles to each other, when the rods pass through a shaft. Shaft *A* is first drilled to take rod *B*. After rod *B* has been inserted and properly located, another hole is drilled at right angles to the first, to receive rod *C*. The distance between the centers of the two holes is made less than the diameter of the stock used for the rods, so that the drill will cut into rod *B* slightly, when drilling the second hole. Rod *C* is then inserted and properly located, after which another hole is drilled and reamed to receive taper pin *D*, as shown. When



Method of securing Two Rods at Right Angles

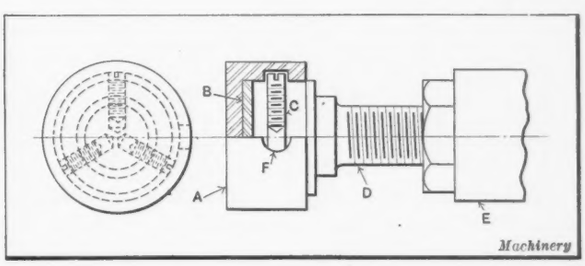
pin *D* is driven into place, it locks rod *C* securely, and rod *C*, in turn, locks rod *B*.

Baltimore, Md. HENRY R. BOWMAN

REVOLVING STOP FOR SCREW MACHINE

The revolving stop shown in the accompanying illustration was designed for use in an automatic screw machine or other machines such as turret lathes, where the stock to be machined is chucked while the spindle is revolving. The writer has found that a better quality of work will be produced when this stop is employed in place of the stationary type of stop generally used. In addition, it also reduces the time required to keep the machine adjusted, since it does not become scored or loaded with metal, as is frequently the case with the stationary type. The stop consists simply of a hardened and drawn steel cap *A*, a bronze bearing washer *B*, three evenly spaced set-screws *C*, and a shank *D* which is adjustable in holder *E*. It will be noticed that an annular groove is cut inside cap *A* into which the heads of screws *C* project. These screws are inserted through a hole *F*, drilled through cap *A*, and prevent the cap from slipping off the end of part *D*.

Akron, Ohio BERKLEY E. WIGGLESWORTH



Revolving Stop for Screw Machine

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PROBLEM INVOLVING THE USE OF TRIGONOMETRY

R. T. R.—In the accompanying illustration, $a = 1\frac{1}{4}$ inches, $h = 4$ inches, and angle $A = 12$ degrees. Please show how to find distance x and angle B.

ANSWERED BY L. D. CASTOR, ELIZABETHPORT, N. J.

In April MACHINERY, page 792, under the title "Problem Involving Algebra and Trigonometry," a solution involving considerable algebra was given to this problem. The writer

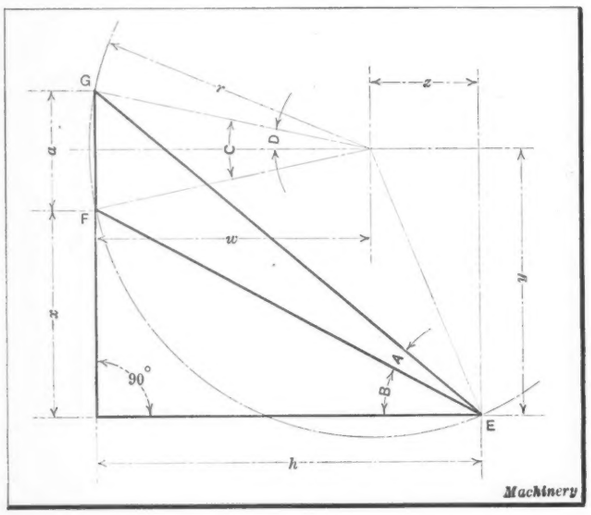


Diagram used in Trigonometric Solution

believes that the solution here presented is much simpler than the one referred to. Draw an arc through points E, F, and G, as shown, with r as a radius. According to a well-known theorem of geometry, which is given on page 250 of MACHINERY'S HANDBOOK, if an angle at the circumference of a circle, between two chords, is subtended by the same arc as the angle at the center, between two radii, then the angle at the circumference is equal to one-half the angle at the center. This being true, angle C is twice the magnitude of angle A, and angle D = angle A = 12 degrees. It will now be readily observed that

$$r = \frac{a}{2 \sin D} = \frac{1.25}{2 \times 0.20791} = 3.0061$$

$$w = \frac{a}{2} \cot D = 0.625 \times 4.7046 = 2.9404$$

and

$$z = h - w = 4 - 2.9404 = 1.0596$$

Now

$$y = \sqrt{r^2 - z^2} = \sqrt{7.9138505} = 2.8131$$

and

$$x = y - \frac{a}{2} = 2.8131 - 0.625 = 2.1881 \text{ inches}$$

Finally,

$$\text{Tan } B = \frac{x}{h} = \frac{2.1881}{4} = 0.54703$$

and

B = 28 degrees 40 minutes 47 seconds

A similar solution was submitted by C. N. Pickworth, Manchester, England.

CALCULATING DIAMETER OF ROLL FOR ROLLER CLUTCH

W. A. Z.—In the accompanying diagram are shown the conditions encountered in the design of a roller clutch. From the dimensions given, please explain the method of finding the diameter of the roll.

ANSWERED BY W. W. JOHNSON, CLEVELAND, OHIO

A.—Referring to the diagram, the diameter of the roll can be found in the following manner: Since, by construction, $MK = KL$, angle KHM = angle KHL = ½ (90 degrees $- x$)

Let ½ (90 degrees $- x$) = y; then,

$$KL = r \tan y$$

and

$$LA = HN = b - KL; \; HN = b - r \tan y$$

$$HO = \sqrt{(HN)^2 + (NO)^2}$$

But

$$HO = R - r$$

Therefore

$$\sqrt{(b - r \tan y)^2 + (a + r)^2} = R - r$$

Squaring both sides of the preceding equation,

$$(b - r \tan y)^2 + (a + r)^2 = (R - r)^2$$

Expanding, combining, and arranging terms with reference to r, we get the quadratic equation

$$r^2 \tan^2 y + 2r \, [(R + a) - b \tan y] - (R^2 - a^2 - b^2) = 0$$

Solving this equation for r,

$$r = \frac{-[(R + a) - b \tan y] \pm \sqrt{(R + a)^2 - (R + a) \tan y \, [2b - (R - a) \tan y]}}{\tan^2 y}$$

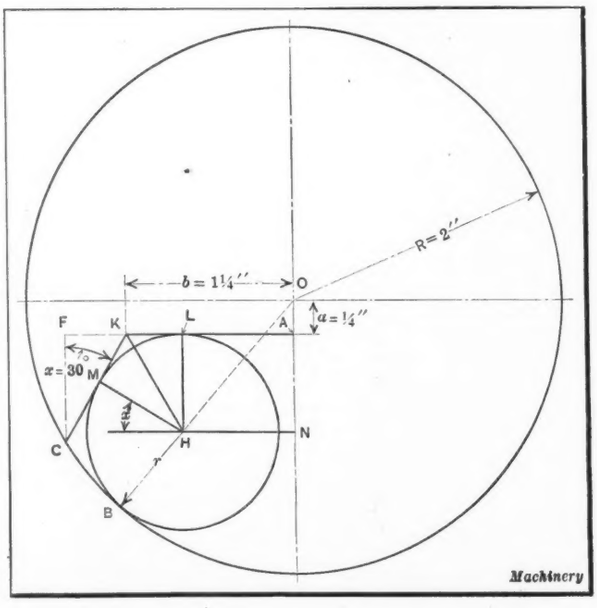


Diagram for finding Diameter of Roll for Roller Clutch

Now, y = ½ (90 deg. $- x$) = 30 degrees. Tan 30 deg. = $1/3\sqrt{3}$ and $\tan^2 30$ deg. = 1/3. Inserting these values of $\tan y$ and $\tan^2 y$ and those given in the diagram, in the foregoing equation, and taking the plus value of the quantity under the radical sign, we find that

$$r = \frac{\sqrt{3.12740} - 1.52831}{0.33333}$$

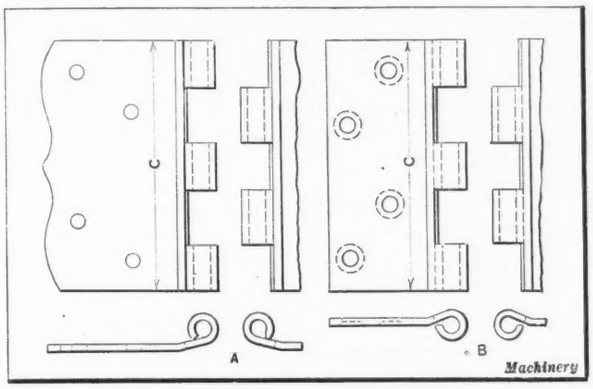
$$= 3(1.76844 - 1.52831)$$

$$= 3 \times 0.24013 = 0.7204 \text{ inch}$$

The diameter of the roll, then, is equal to $2r$ or 1.4408 inches.

MANUFACTURE OF HINGE BUTTS

C. L.—Can any reader of MACHINERY give information as to the methods in use in some shop for manufacturing hinge butts of the two styles illustrated at *A* and *B*, in



Types of Hinge Butts of which Information is desired concerning Manufacturing Methods

various sizes of which *C* ranges from 1 to 4 inches? It is desirable that only tools actually used in producing such parts be described and that production figures be given.

DETERMINING ALTITUDE OF AN ACUTE-ANGLED TRIANGLE

A. A. G.—Will you please show how to find the distances x and y from the dimensions given in the illustration?

ANSWERED BY W. W. JOHNSON, CLEVELAND, OHIO

A.—Referring to the illustration, we have

$$y^2 = R^2 - x^2 \qquad (1)$$

$$y^2 = r^2 - [(R + r - c) - x]^2 \qquad (2)$$

From Equations (1) and (2) by comparison,

$$x = \frac{R^2 + (R + r - c)^2 - r^2}{2(R + r - c)} \qquad (3)$$

Substituting this value for x in Equation (1), we get

$$y^2 = \frac{[2R(R + r - c)]^2 - [R^2 + (R + r - c)^2 - r^2]^2}{4(R + r - c)^2}$$

Then,

$$y = \frac{\sqrt{[2R(R + r - c)]^2 - [R^2 + (R + r - c)^2 - r^2]^2}}{2(R + r - c)}$$

Factoring and reducing the terms under the radical sign in this equation,

$$y = \frac{\sqrt{([(R + r - c) + R]^2 - r^2)\ (r^2 - [(R + r - c) - R]^2)}}{2(R + r - c)} \qquad (4)$$

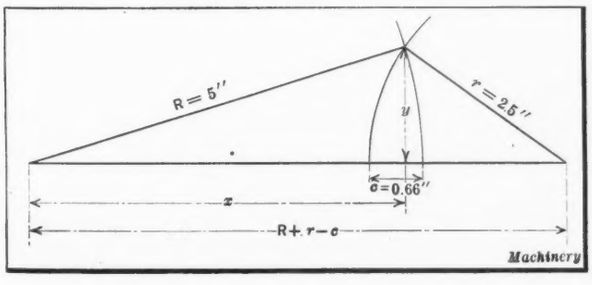


Diagram for calculating Distances x and y

Substituting numerical values for the known quantities in Equations (3) and (4), we find that

$$x = \frac{65.5356}{13.68} = 4.7906 \text{ inches}$$

and

$$y = \frac{\sqrt{133.9356 \times 2.8644}}{13.68} = 1.4318 \text{ inches}$$

TANGENCY PROBLEM

L. M. S.—Referring to the accompanying illustration will you please show how to find angle y without involving the use of higher mathematics? Let it be assumed that in this problem a equals 5.5 inches; b, 3 inches; and R, 1.625 inches.

ANSWERED BY J. F. THORNTON, CINCINNATI, OHIO

The following method of solving the problem stated requires only an elementary knowledge of trigonometry and the use of a table of trigonometrical functions. According to trigonometry,

$$\text{Tan } x = \frac{b}{(a - R)}$$

and

$$t = \sec x \times (a - R),$$

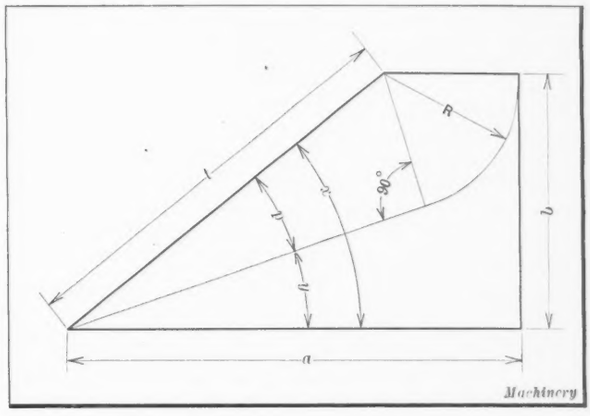
also

$$\text{Sin } p = \sin (x - y) = \frac{R}{t}$$

and

$$y = x - p$$

Substituting the known values and solving,



Conditions of Tangency Problem

$$\text{Tan } x = \frac{3}{3.875} = 0.77419 = \text{tan 37 degrees 44 minutes}$$

and

$$t = 1.2644 \times 3.875 = 4.89955$$

Also

$$\text{Sin } (x - y) = \frac{1.625}{4.89955} = 0.33166 = \text{sin 19 deg. 22 min.}$$

Therefore,

$$y = 37 \text{ deg. } 44 \text{ min.} - 19 \text{ deg. } 22 \text{ min.} = 18 \text{ deg. } 22 \text{ min.}$$

* * *

A machine tool dealer in Germany, writing on the prices of machine tools in that country, states that standard machines of first-class quality, such as lathes, milling machines, grinding machines, upright and radial drilling machines, planers, etc., cost about 10 to 11.5 marks (11 to 13 cents present exchange) per pound, net weight. First-class American machine tools in the German market, with ocean freight and import duty into Germany added, cost about 30 marks (34.5 cents) per pound. Machine tools of the cheaper class of German make cost only from 7 to 9 marks (8 to 10 cents) per pound.

Demand for Machine Tools in India

By GEORGE CECIL

THERE was a time when European employers of native labor in India did not encourage the use of imported tools; and the obstinate native mechanic also, for many years, fought shy of modern tools and methods, anything in the way of a time-saving device being objectionable to him. The longer he worked, the greater his profit, so he thought; consequently, he allowed his task to drag on. Finally, employers and mechanics alike more or less fell into line with the new order of things, and today machine tools have been adopted in the mill repair shops; indeed, many of them are particularly well equipped.

India being preeminently conservative, this result was not achieved without a severe struggle. The native argued that his father, grandfather, and great-grandfather had used tools of Indian manufacture, and nothing would, at first, induce him to desert those to which he had been accustomed from his youth. But by degrees contractors and other employers of labor came to the conclusion that "time is money." Today, though the old-fashioned users of native tools refuse to bend their knees to progress, they are, fortunately, in a minority. As to the European concerns, both large and small, they expend money freely in acquiring suitable tools, a certain pride being taken in the shops.

General Industrial Conditions

Of late, India has, for an Eastern country where progress seldom is encouraged, been unusually active industrially. Some of the railway companies, for example, have constructed their own locomotives with good results. For many years past, most companies have made their own cars, India being rich in suitable lumber. The shops are well equipped, and skilled European foremen, brought from England, are in charge. Under their fostering care the natives, who are employed by the thousand, often do very good work—they can, in fact, hardly be excelled. When, however, a supposed economy is effected by putting an incompetent and inexpensive half-caste native in charge, the quality of the output usually falls off. The semi-white man is naturally indolent; he seldom masters the use of the machinery entrusted to his care, and the men dislike working under him.

Some of the small native shops in which machine tools are used serve apparently as an outlet for mere rubbish in the way of tools and machines. Obsolete contrivances, instead of being "scrapped," are purchased for a trifle by the economical Indian mill or mine owner, and those who use them are but poorly acquainted with their operation. One finds an antiquated lathe in a repair shop, with a venerable native endeavoring to operate it. The lathe is coated with rust; so, too, is the mind of the operator.

Types of Machine Tools in Demand

A small percentage of the machine tools in local use are manufactured in India, but the number imported is by far the most important. Milling and drilling machines and woodworking machinery are in demand; light gap lathes (12-inch swing), heavier gap lathes (16-inch swing), screw machines, bolt- and nut-making machinery, shapers, and saws are needed. Woodworking machines are used in Calcutta, Bombay, Madras and elsewhere. The market, while not unlimited, is well worth the exporters' close attention. India has many capitalists, both native and European. With a little urging, they often are ready to launch out upon new enterprises.

Both Japan and Germany have made frantic efforts to capture the Indian market. The Japanese products, unfortunately, seldom are like the samples, or representations made. German manufacturers have not always kept their word, a failing which neither European nor native machinery users are inclined to tolerate. The Indian himself may not be a model of all the virtues; but he has a great admiration for the exporter whose honesty is unassailable; and it must be confessed that during many years' trading with India, Germany has scarcely earned a reputation for upright dealing.

Small Tools in Demand

The demand for small tools is considerable. The European tea and indigo planters provide themselves with tool-chests, for in many cases the exiled agriculturist is far from the haunts of the native mechanics. Missionaries are in the same position, and government officials who find themselves in isolated spots are forced to supervise, if not to undertake, domestic repairs. Well-stocked tool-boxes may be found in the large hardware establishments, but they seldom include everything that is required. A really complete box would need to be very large—a miniature shop. It should contain everything by means of which the possessor may perform temporary repairs of all kinds—both in wood and metal—and should include even a lavish supply of nails and screws. As to the nature of the tools used in India, they are the same as those required in other countries. The native, though haggling over prices, knows when he is getting value for his money.

Dealers in Machinery and Tools

In the three main cities, Calcutta, Bombay, and Madras, there are many reputable machinery and small tool dealers. They generally know their business; and they are as active as the enervating climate permits them to be. The consul at each town should be in a position to vouch for their standing and capabilities. Calcutta and Bombay support hardware establishments of repute, all of which deal largely in small tools. Both the machinery agents and the hardware men are in a position to know what is wanted, and they possess the necessary means of distribution. Their travellers constantly are on the move; they are in complete touch with requirements—both European and native. Consequently, the manufacturer who aspires to conquering the Indian field may safely leave his interests in their hands.

The large mercantile houses also are ready to undertake agencies for the sale of anything—"from a needle to an anchor." Jute firms, cotton firms, wine merchants, even tailors—all are willing to pose as agents for lathes and drilling machines, hammers and nails. These people are, of course, worse than useless as agents or representatives.

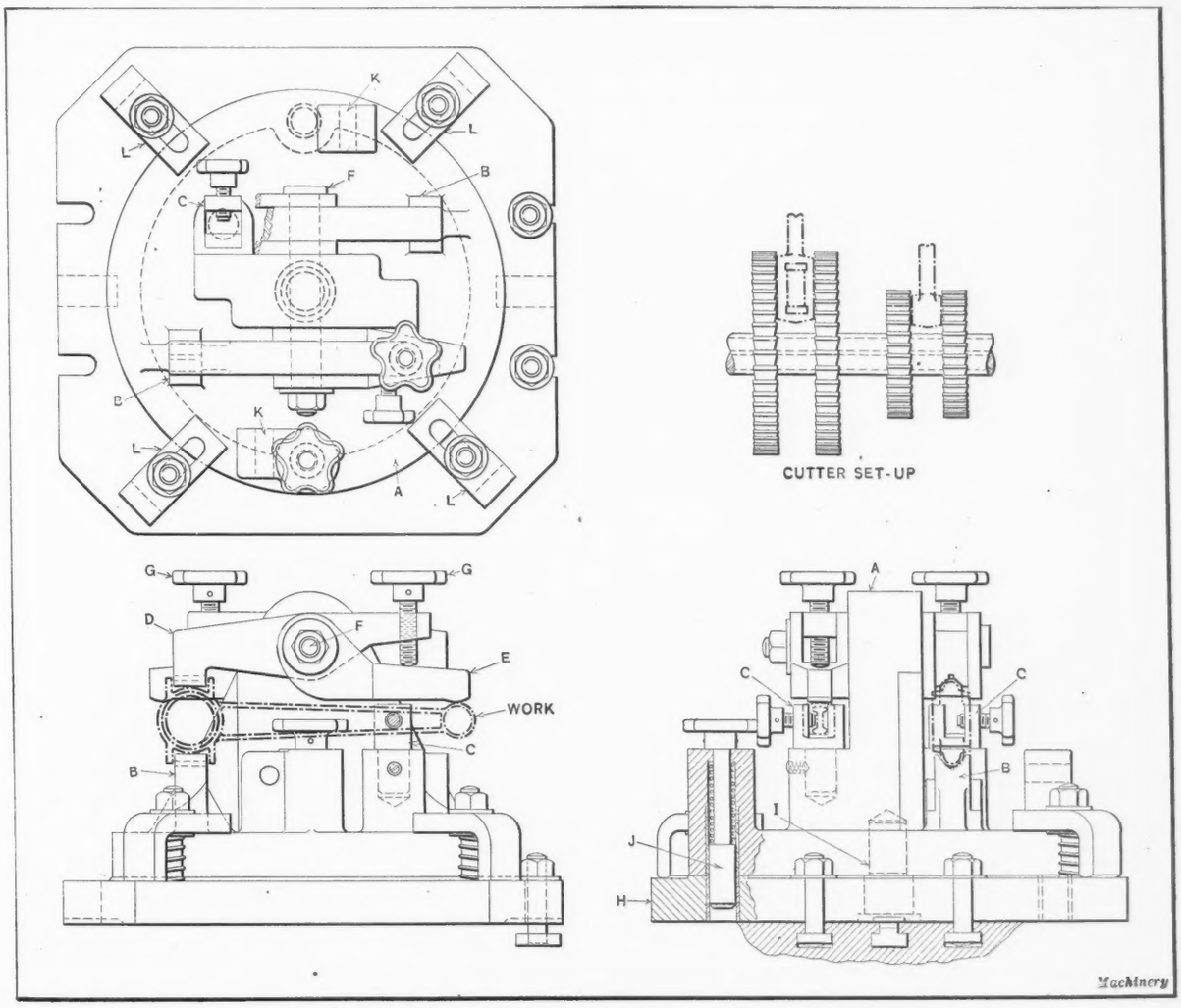
* * *

A number of automobile manufacturers in France have recently formed a combination known as L'Union Commerciale des Marques Francaises, capitalized at 1,500,000 francs. The object of this organization is to develop foreign markets by securing capable agents throughout the world for automobiles; it is stated that the organization will also handle machinery in general. The office of L'Union Commerciale des Marques Francaises is at 2 rue du Bois de Boulogne, Paris.

STRADDLE-MILLING FIXTURE FOR CONNECTING-RODS

By CLARENCE M. SCHLEH

In machining the faces of crankpin and wrist-pin bearings of automobile connecting-rods it is essential that these surfaces be finished correctly in relation to each other, and also that they be held as closely as possible in alignment with the web and bolt bosses of the forging. Connecting-rods are made as light as possible, and so the bolt holes usually have only from ⅛ to 3/16 inch thickness of wall. Therefore, if the bearing faces should be milled off, say 1/16 inch, in relation to the center line of the rod, through some faulty method of setting up the work, and the holes are drilled and reamed by means of jigs, the holes would be located 1/16 inch off the center of the bolt bosses, as the rods are located in the jig for drilling and reaming, from the milled bearing surfaces. One way of accurately machining the bearing faces is by using a fixture such as shown in the accompanying illustration, which is designed for straddle-milling. Its construction and operation are simple.



Indexing Fixture used in straddle-milling the Bearing Faces of Automobile Connecting-rods

The fixture is used on a Milwaukee horizontal-spindle milling machine with a double over-arm construction. The bearings on the connecting-rod for which the fixture was designed are of two different lengths. If they were of the same length it would have been a simple matter to make a fixture in which one or more rods could be secured, mill one end of the rods first, then lower the table to permit the cutters to clear the fixture, traverse the latter past the cutters, again raise the table, and finally mill the opposite end of the rods. In the present case this procedure was impossible, because the distance between the cutters on the arbor would have to be altered to suit the two bearings, and so there were but two alternative methods of machining. Either the work must have to be reset for milling the second end or else a fixture must be provided which would permit the milling of opposite ends of two rods at one time, and then could be indexed for milling the other two ends. The fixture developed was based on the second of these principles.

The two connecting-rods are mounted on the fixture as indicated by the heavy dot-and-dash lines, a large end of one rod being placed beside a small end of the other rod. The larger end of each rod is located by having the bolt boss on the lower side rest in the V-groove of a lug *B* cast integral with the rotary body *A*, while the upper bolt boss is held in a V-groove in clamp *D*. Lugs *B* are narrower than the connecting-rod bearing which they support, for a sufficient distance beneath the work to permit the cutters to finish the bearing faces without interference with the fixture. The I-section close to the small end of each rod is supported in the slot of a steel block *C*, which has a shank that is a pressed fit in a hole in the body, and is held by means of a small headless set-screw. The I-section of the rod is forced against the inside wall of the slot by means of an adjusting screw. This locating arrangement permits both bosses on the large end of each rod and the web to be brought approximately in line with the cutters.

After a connecting-rod has been located as described, it is secured in place by means of clamps *D* and *E*, the former bearing on the large end as already mentioned, and the latter on the small end. There are, of course, two sets of

clamps, all four fulcruming on pin *F*. Each set of clamps is brought to bear on the corresponding connecting-rod by adjusting a screw *G*, which is contained in a threaded hole in clamp *D* and bears on clamp *E*, thus affording a quick-acting device. Body *A* may be rotated on base *H*, being pivoted on the vertical pin *I*, and there are two bushings located 180 degrees apart to accommodate spring plunger *J*. When the plunger has been placed in either of these bushings, body *A* is clamped to base *H* by means of clamps *L*. Then the work is fed past the cutters mounted on the arbor as shown in the upper right-hand corner of the illustration until the ends nearest the cutters have been machined.

The table is next withdrawn, clamps *L* loosened and swung sidewise, plunger *J* lifted and body *A* revolved by means of a round bar inserted in either one of the holes *K*, until the plunger, as it rides on the finished surface of the base, springs into the bushing opposite the one in which it was placed during the first step. After clamps *L* have been retightened, the opposite ends of the work are fed past the cutters, and when the machining of these ends is completed, the table is again withdrawn and two new rods are mounted in the fixture. Base *H* is held in the correct alignment on the table by two keys attached by means of screws in slots on the under side of the base, these keys fitting the center T-slot of the table. The base is attached to the table by means of four bolts. It is preferable for a machine to be equipped with two of these fixtures, as then, while the work in either of the fixtures is being fed past the cutters, the other fixture may be indexed or reloaded with unfinished forgings. Thus an almost continuous milling operation will be obtained.

* * *

HYDRAULIC ACCUMULATORS AND PIPING SYSTEMS

By A. SEARLES

To the writer's knowledge, there is no class of factory equipment that requires more painstaking care in the design, installation, and operation than that included in hydraulic systems, on account of the severe service to which such equipment is subjected as well as the danger involved by storing up an enormous amount of energy, the release of which, due to the failure of some part to function properly, might cause serious damage. This is especially true of systems having an accumulator of large capacity, where the stored energy amounts to millions of foot-pounds, including floating ballast weighing several hundred thousand pounds.

To begin with, a consideration of the accumulator may be of interest. There are two types of accumulators in common use, namely, those having a stationary ram with the ballast attached to the floating cylinder, and those having a ram attached to, and movable with, the ballast weight. The former arrangement is the more common, although open to some rather serious objections as to accessibility for repairs to the parts most usually in need of attention, such as the ram, which may in time become so badly scored by the packing and foreign material that excessive leakage and consequent loss of power make it imperative that it be removed and refinished. If a cast-steel ram proves defective and leaky from sponginess, for instance, a total dismantling of the accumulator is necessary in case the ram is of the stationary type. This is no small task, involving as it does the removal of the cylinder, and ballast, the latter often weighing several hundred thousand pounds and consisting of such material as iron ore or steel punchings, the removal of which requires considerable manual labor. The movable ram, on the other hand, may be detached from the ballast tank and lifted clear without disturbing the other parts. This type also permits easy access to the gland bushing of the cylinder, which must be replaced on account of the reduction of the ram diameter if the latter is refinished. An accumulator of this design also has the advantage that the outside of the cylinder may be inspected for leaks without difficulty; while the ballast of the previously mentioned design hinders or prevents such an inspection.

Construction of Accumulators

The materials from which accumulators are constructed should be given careful consideration. For moderately high pressures of 1600 pounds or less, cast iron is satisfactory for both cylinder and ram, as the castings can generally be relied on to be free from blow-holes and such defects as result in leaks. Cast iron of a proper grade, namely, gray iron, also seems to lubricate easily, probably due to the graphitic content; at any rate, under reasonable conditions the ram soon takes on a glossy surface, thus promoting the best operating conditions. For higher pressures, the cylinder is usually made of cast steel, and while the same material is commonly used for the ram, it is not to be recommended, as a steel casting of such proportions is frequently honeycombed, and although it may withstand a pressure test, subsequent and continued operation may eventually force the water through, and open serious leaks in the spongy spots. Considering that such a condition may not be entirely corrected by plugging or electric welding, it is much more satisfactory to equip the accumulator with a forged steel ram in the first place. Although the first cost may be slightly greater, the additional insurance against leakage would seem to be justified.

Accumulator gland packing requires careful attention in that it must be fitted and compressed to avoid leakage, as all leaks represent a considerable loss of power since, for instance, a loss of 14.3 pounds of water per minute from a system operating under a pressure of 1000 pounds per square inch represents one horsepower and a proportionate power loss at other pressures. Soft metallic packings seem to give good results for accumulators, without wearing the ram unduly as is often the case where hemp and other hard fabric packings are used. A means of lubricating the ram is found advantageous when water is used as the fluid medium in the system. Lubrication may be accomplished satisfactorily by attaching a ring or swab of absorbent fabric to the outside of the gland and encircling the ram; this ring is kept saturated with oil which works off on the ram through contact with the ring.

To prevent such awkward and dangerous occurrences as the over-traveling of the accumulator due to the failure of the by-pass valve or pump regulator, which would result in pumping the moving element of the accumulator up to such a point that the ram emerges from the cylinder with the probability of a serious wreck from the falling of the moving element, manufacturers provide release holes in the ram which become uncovered or exposed when for any reason the accumulator over-travels. These holes are drilled radially in relation to the axis of the ram and enter the central hole in the ram, thus forming a vent to the whole system; they must be sufficiently large to relieve the system as fast as the pumps can deliver.

Design and Installation of Piping Systems

Hydraulic piping systems must be carefully designed and installed so as to avoid as far as possible any danger to life and property. A case is known where a large accumulator was wrecked, because the piping was of such capacity as to permit the accumulator to drop at an excessive speed. This may be avoided by so proportioning the piping as to prevent an excessive rate of flow, or by properly regulating the operating valve opening to the presses, but better still by installing a suitable check valve at the accumulator connection. This valve has a hole which regulates or throttles the flow from the accumulator, but opens, if necessary, to permit the pumps to deliver at a higher speed. This arrangement has the added advantage of safely regulating the lowering of the accumulator in case of failure in the system, such as a split pipe, joint gasket blow-out, or other causes tending to release the water at an undue rate. The piping

of a hydraulic system must be rigidly restrained at short turns to avoid the danger of breaks due to the jarring and springing resulting from the sudden changes in speed of water flow due to the sudden opening and closing of operating valves. For this reason it is desirable to install piping with long bends of pipe, where possible, in place of short-radius fittings. Even when this is done, if the runs of pipe are of such length as to involve a large capacity of water, representing considerable force at high rates of flow, additional protection of the pipe from shock must be provided by the installation of shock valves.

Location of Pipes

Where possible, it is best to install high-pressure pipe in trenches below the floor level, as overhead installations increase the danger to operators from leaks due to splits in the pipe and failure of joints. It is also a better location for the restraining devices at the pipe elbows. An overhead system may transmit disagreeable if not dangerous vibrations to the building. Flanged pipe joints, which are commonly used, should be guarded by a metal ring as a matter of safety to operators in the event of a leak.

Oil and water are the liquid mediums used in hydraulic systems. Oil has the advantage of lubricating the moving parts throughout the system and maintains an excellent condition of such parts as accumulator rams, pump pistons, and press rams, but has the disadvantage of higher cost, while water is a fair substitute, if treated with a good emulsifying lubricant, such as used for cutting compounds.

Some systems give trouble from considerable heating of the fluid medium due to the small storage capacity, which does not present sufficient radiating surface to carry off the heat generated by the friction of the fluid flowing through small passages in the system, such as partially closed operating valves, or from by-passing when the pump regulator has cut the pump off the line. This is often destructive to packings, and it may be found necessary to discharge the liquid into a cooling apparatus before returning it to the storage reservoir.

Advantages and Disadvantages of Direct System

Generally a system which pumps directly to the presses without an accumulator is more economical from the standpoint of power, as many operations require full pressure for only a short portion of the stroke of the press. However, this arrangement has certain disadvantages. If the operation is such as to limit the stroke definitely at a certain point, the pressure will increase enormously, and probably cause damage to the equipment, although relief valves may be installed to safeguard against this condition. Again, unless the system is quite free from leaks, the pulsations of the pump strokes may be so amplified as to show in the product, especially extruded material. In order to effect a saving of power, a double-pressure system is frequently employed, which involves a double-pressure pump or two pumps—one for low and the other for high pressure. This further complicates the piping and valves, and may even require two accumulators. The low-pressure pump operates during the early portion of the stroke and when insufficient to continue its operation, is discontinued and the high-pressure pump applied. The direct system necessitates the use of individual pumps for each press, while the system including an accumulator may serve more than one press.

Operating valves may be considered as necessary evils, as they require the most constant and careful attention to insure against leaks; consequently the first consideration in their design is accessibility for repairs—they should be so constructed as to obviate the necessity of removal from the line for repairs and repacking. For pressures up to 1600 pounds per square inch, some forms of balanced piston valves give satisfaction, but pressures of 4000 to 5000 pounds require a poppet type of valve which may need frequent refacing of the seats due to wire drawing.

MAKING BLANKING DIES

By J. F. THORNTON

Antiquated methods and devices, many of which cause undue strain on the workmen's eyes, are still employed to a considerable extent in making blanking dies. The use of such methods and devices should be discouraged, and it is the purpose of this article to explain a method that should have a wider application in diemaking, and come into more general use among diemakers to replace the older, inaccurate, and time-wasting methods. Endeavoring to "split a scribed line with a file," that is, relying only on one's ability to determine by sight when the metal has been filed away until the center of the scribed line has been reached, is a practice that should be discontinued, as the method here described and illustrated will, in almost every case, give more accurate results and permit the work to be done in much less time.

An outline of the opening in a simple piercing and cutting-off die is shown in the upper left-hand corner of Fig. 1. The making of a die of this kind is facilitated by the use of hardened disks as guides for the diemaker's file, the position of these disks being indicated by the dotted circles *A*. Hardened parallels, the positions of which are indicated by the dotted lines *B*, are also used as guides when filing the straight portions of the die-opening. The disks should ordinarily be made from stock ⅛ or 3/16 inch in thickness. As the profile of the punch used with this die is exactly the same as the profile of the work, the radius *R* of the die should be slightly smaller than the radius of the work. The metal to be punched in this case is steel, so 1/40 the thickness of the stock should be subtracted from the radius of the work in order to obtain the correct radius *R* for the die. For work requiring ordinary accuracy, or for work having limits of plus or minus 0.002 inch, the disks may be turned and bored on a lathe, and then hardened. When extreme accuracy is required, they should be hardened and ground all over and located by the use of gage-blocks or a height gage. The disks employed in making dies can be used over and over, so that it is not usually necessary to charge up the cost of making them to any one job. A set of parallels and disks consisting of four 2-inch and four 4-inch parallels, and a few disks of the more commonly used sizes will cover a surprisingly large range of work, and should be included in every toolmaker's kit. Disks which are not of a standard size should be stamped with the tool or die number on which they are used, to facilitate identification.

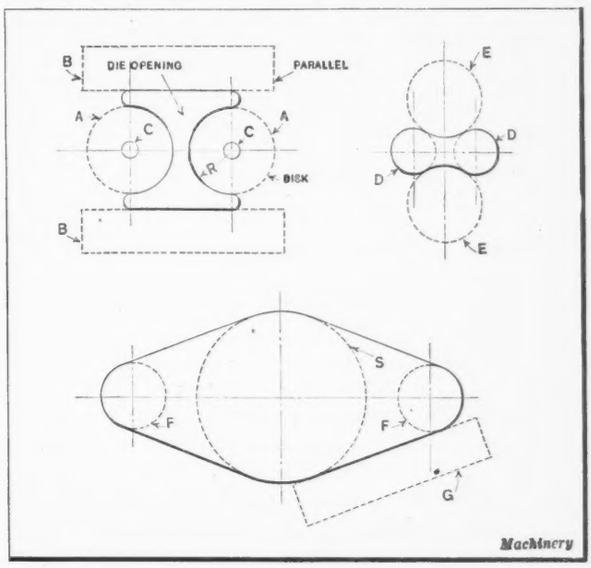


Fig. 1. Use of Hardened Disks and Parallels to guide File when filing Die Opening

Since the forms or outlines of practically all dies consist of combinations of true geometric figures, it is evident that there are but few cases in which disks and parallels cannot be used to advantage. The disks and parallels, or "masters," as they are sometimes called, are intended to be used as guides for the workman's file, and thus prevent the opening in the die from being filed beyond the limiting profile line. It is true that a file in the hands of a careless workman will be quickly dulled by continually striking the hard edges of the disks, but the number of unskilled workmen to be found in tool-rooms is, or should be, very small.

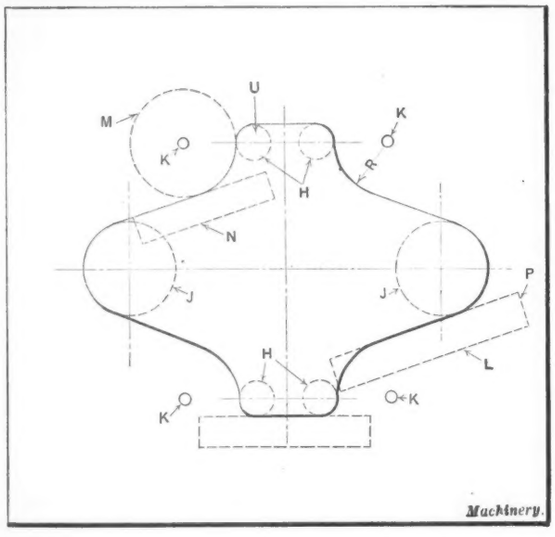


Fig. 2. Method of drilling Small Holes in Die to facilitate Location of Disks

Regarding the setting of the disks *A*, the two piercing holes *C* should first be laid out, drilled, and reamed. The disks in this case should have central holes of the same diameter as the piercing holes in the die. This permits the disks to be located by pushing small plug gages through the holes in the disks and into the die. The disks may be clamped or soldered in place, great care being taken, if they are soldered, to see that the heat does not change their position. Parallels *B* are then located in their proper relation to the disks, after which the core of the die is removed by drilling or sawing. The locating or attaching of the "masters" before removing the core will prevent drilling or sawing into the metal beyond the outline of the die profile.

In making a die having a profile such as indicated in the view at the upper right-hand corner of Fig. 1, it is evident that holes *D* should be laid out and bored first, after which plugs placed in these holes may be used in locating hardened disks in the positions indicated by the dotted circles *E*. After the disks have been attached to the die, the plugs are removed from holes *D* and the die opening filed to shape.

The method of using disks and parallels in making a die having an opening or profile such as indicated in the lower view in Fig. 1, is evident, and should require but little explanation. The positions and relative sizes of the disks required in making this die are indicated by the dotted circles *F* and *S*, while the position of one of the parallels is indicated by the dotted lines at *G*.

The contour or outline of the die shown in Fig. 2 is such that all the disks or "masters" required cannot be placed on or attached to the die at one time. After the four holes *H* and the two holes *J* have been bored, four small holes *K* should be drilled in the die, if this is permissible. The drilling of these small holes will facilitate the placing of parallels such as indicated by the dotted lines at *L*. After the sides of the die opening determined by these parallels have been finished, the parallels are removed, and disks having the correct radius *R* are attached to the die, being located by holes *K*.

The position of one of the disks located in this manner is indicated by the dotted circle at *M*. If it is not permissible to drill holes *K* in the die, the disks may be located against parallels clamped to the die. The correct position of a parallel used for this purpose is indicated by the dotted lines at *N*. With a parallel in this position, the disk can be properly located by bringing its edge into contact with both the parallel and a plug inserted in hole *H*. After attaching the disk to the die, the plug and parallel are removed, and the profile of the die filed to shape in the manner previously described.

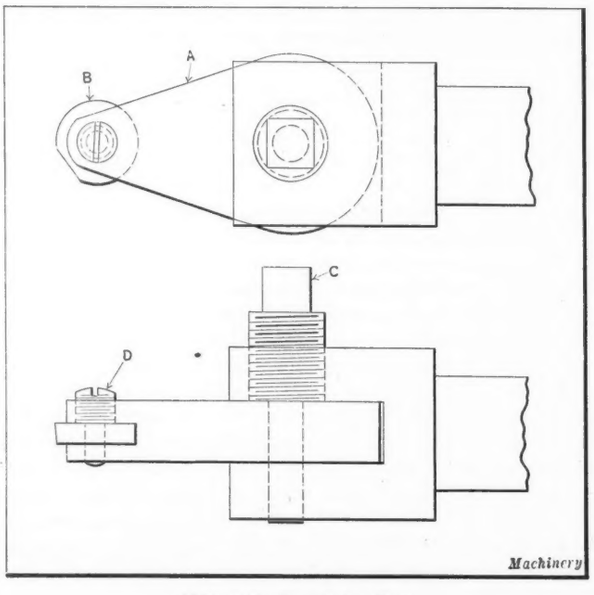
The "masters" are exceptionally useful when making shaving and burnishing dies having perpendicular walls or no clearance angle. For dies of this kind disks should be placed both on the face and on the back of the die blank. Care must, of course, be taken to see that the face of the die is parallel with the back of the die, and a height gage or other accurate gaging methods must be employed in setting the "masters." It is the writer's belief that using disks as described, instead of attempting to file to scribed lines will reduce the cost of diemaking as much as 60 per cent.

* * *

CHAMFERING TOOL

By HARRY MOORE

In cutting either internal or external threads on a hand-screw machine, it is necessary to chamfer the end of the work before bringing the threading die or tap into operation. The tool shown in the accompanying illustration was designed to perform the required chamfering operations, and it proved more satisfactory than the hand tool commonly employed for this purpose. In addition to performing chamfering operations, it is also used for cutting rings in faces of fittings which are required to be water-tight.



Adjustable Chamfering Tool

Referring to the construction of the tool, piece *A*, which holds cutter *B*, is drilled to receive the special holding screw *C*. The front end of part *A* is slotted and tapped for the screw *D*, which holds cutter *B* in place. All parts are made of machine steel except cutter *B*, which in this case is made of tool steel. In setting the tool, arm *A* is swung and cutter *B* adjusted to give the required chamfer. When properly set, screws *C* and *D* are tightened to hold the cutter in position. The advantage of using a cutter of circular form is that as the position of arm *A* is altered, the cutting face of the tool can be swung around to produce a 45-degree chamfer. The circular cutter can also be ground many times before it is necessary to replace it.

ASSEMBLING DEVICE FOR PULLEYS, HANDWHEELS AND GEARS

A motor-driven draw-bench is used by the Hopedale Mfg. Co., Milford, Mass., for forcing such parts as handwheels, pulleys, and gears on the ends of shafts which have previously been lined up in their machine bearings. This device is used primarily in connection with the erecting of cotton looms, the crankshafts of which extend beyond the sides of the frame and carry pulleys and similar parts which are regularly assembled after the crankshafts have been fitted in their bearings. Although this device was especially constructed, the principle involved is of general application where assembling methods of a like nature are encountered.

The device consists of a four-legged iron table on which is mounted a reversing motor which drives a train of reducing gears, compactly mounted on the top of the table. The table top is not more than 2½ feet square, and when not in use the entire device takes up very little space. The final gear in the reducing train is fitted to a hollow threaded arbor so that as the gear revolves it advances on this arbor. On opposite sides of the table top there are cast two slotted lugs, the slots being about 2 feet apart, the position of which is indicated in the diagrammatic sketch which accompanies this article. Two long reach-rods, yoked together as shown at *A*, are used when drawing the parts to be assembled on the projecting end of the crankshaft. The nuts for the threaded end of the two long rods form a bearing against the vertical surface of the lugs on the table, while the bar which joins the two rods rests against one arm of the crankshaft. The threaded arbor previously mentioned has a hole extending through it which is of sufficient diameter to receive the projecting end of the crankshaft, so that as the hub of the gear advances into contact with the handwheel, gear or pulley, as the case may be, the part will be forced on the shaft. The pressure exerted against the end of the part to be assembled has a tendency to force the table

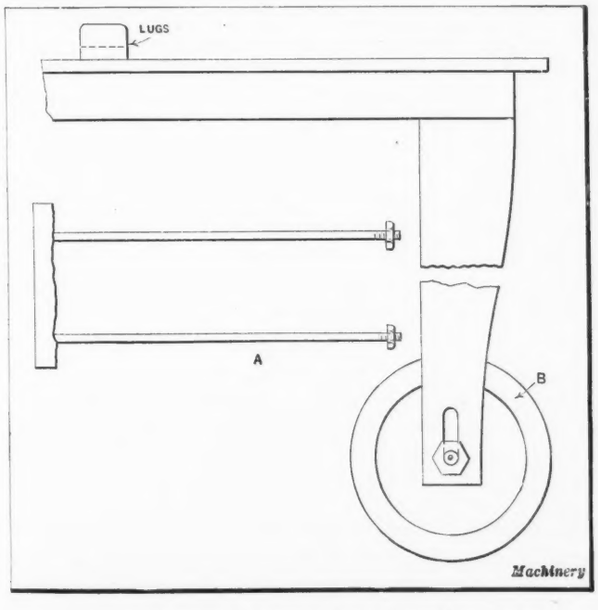


Diagram illustrating Features of the Assembling Device

away from the side of the loom, but this is prevented by the brace consisting of the two rods and yokes as previously mentioned.

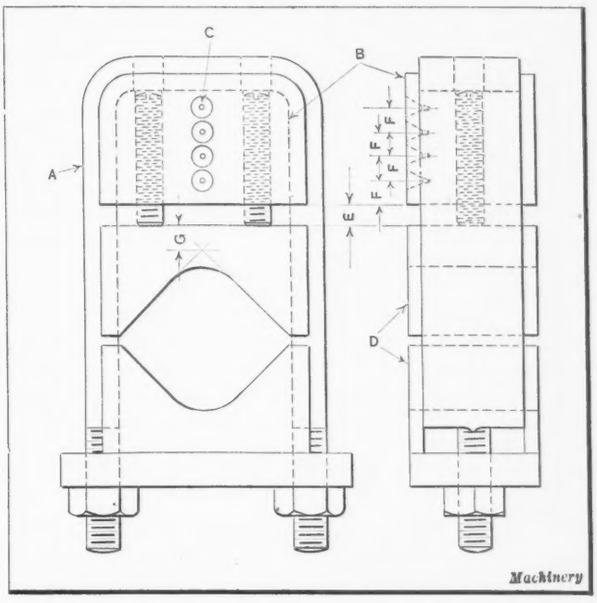
Obviously, there must be some means of adjusting the height of the table so as to bring the center of the threaded arbor into alignment with the center line of the crankshafts of different sizes of looms. This is accomplished by a very simple means. A circular sheave is attached to each leg in a fixed position by means of a bolt passing through an elongated slot. The sheave can then be secured so as to bring the level of the table to the required height, and for the purpose of locomotion a steel rim *B* revolves on the fixed sheave as a center. This arrangement also permits variations in floor levels to be quickly compensated for. By having a reversible motor it is a simple matter to strip such parts as handwheels, etc., from the crankshaft.

* * *

ADJUSTABLE OFFSET DEVICE FOR CRANKSHAFTS

By D. R. GALLAGHER

Automobile repair shops generally keep on hand a quantity of offset fixtures for use in mounting crankshafts between the centers of machines when desiring to turn or grind the crankpins, it being necessary to have a number of fixtures



Adjustable Offset Fixture used in re-turning or regrinding Crankpins

on account of the difference in dimensions existing between crankshafts of various makes and sizes of cars. Although the diameter of the end bearings may be the same on a number of crankshafts, the length of throw is likely to be different. The accompanying illustration shows an offset fixture which is adjustable for the diameter of the end bearings and for the length of throw. It consists essentially of a bent strap *A*, which is finished on all sides, a block *B* provided with four centers *C*, and two sliding V-blocks *D*. One of these devices is placed on each of the end bearings of the crankshaft, blocks *D* being slid apart enough to admit the bearings. The crankpins to be machined must, of course, be in alignment with one of the centers in block *B*. That center which is nearest to the center of the crankpin when the fixture has been placed on the crankshaft is selected as the one to be used in mounting the crankshaft on the machine. The axes of the crankpins are then brought accurately in line with the center to be used, through the adjusting screws in block *B* which control the distance between this block and the upper one of blocks *D*. Blocks *D* should be kept parallel, and feelers used to insure that distance *E* on both offset fixtures is identical. Each offset fixture is finally tightened on the crankshaft by means of the nuts on strap *A*. After a little practice a workman can make necessary adjustments quickly.

Strap *A* may be made from a forging, and block *B* from machine steel and pack-hardened or from a non-shrinking tool steel. The distance *F* between the various centers should be located accurately in each pair of offset fixtures. V-blocks *D* should also be made from steel, hardened and ground to a sliding fit. Dimension *G* must be the same in each fixture of a pair to obtain accurate results. This dimension may be determined by plug or ball measurement.

The Metal-working Industries

THERE has been but little change in conditions in the metal-working industries during the last month. The conditions in the industries throughout the country are practically the same as in the New England district, where the Federal Reserve Bank of Boston made a complete survey covering the month of July. This survey shows that in New England these industries as a whole are operating at approximately one-third capacity, but there is great variation as regards different plants; a few shops work full time, while some are entirely closed down. Activity is greatest in plants making tools, supplies, and hardware for the building trades; and some business is reported from drop-forging plants. A manufacturer of pumps reports the last six months as the best in the history of his business, this line having suffered relatively little from the depression.

While cancellations are now but few, as there are but few old orders on the books that would be subject to cancellation, manufacturers are frequently asked to suspend shipments of machines or other products. A Connecticut manufacturer says: "We have on our books a large volume of business which has been manufactured and is now being held in our shipping rooms, as our customers have held up the orders."

The price situation in the iron and steel industry has been one of the chief problems confronting manufacturers in the metal-working field, and one firm states that it is impossible "to look for improvements until steel prices are sufficiently stabilized so that customers feel reasonably assured that the bottom has been reached, at least temporarily."

The Iron and Steel Industry

There is still comparatively little activity in the iron and steel industry, pig iron production being estimated at 30 per cent of normal, and steel ingot production at slightly over 25 per cent of normal. The only mills reporting improved business are those engaged in sheet metal rolling, several mills having been reopened; but there is evidence of better demand for pig iron and inquiries and orders for steel are increasing, although much of this business is done at the expense of price cuts. A gradual if slow increase in the buying of railway and building materials is reported, and the pig iron market shows a tendency toward becoming more active, due, doubtless, to the low prices now being quoted for this raw material, various grades being sold at base points at from $18 to $20 a ton. The corresponding grades a year ago were quoted at $46 and $46.50 a ton. Prices of finished steel average 2.36 cents a pound, compared with 3.94 cents a pound a year ago. The average price for ten years previous to the war for the same grades of finished steel was 1.68 cents a pound.

The Automobile Industry

So far, seventy-two automobile manufacturers have announced reductions in the prices of their cars. Some of the prices announced are back to the 1918 level. While there has been some revival in sales in consequence of these price cuts, the reductions have not affected the market to the extent expected by the manufacturers. The public appears to be expecting still further reductions, losing sight of the fact that present conditions, taxes, increased overhead due to decreased production, are factors to be reckoned with in making a selling price that will not mean a loss to the manufacturer. Measured in percentages, the reductions range from 5 to 35 per cent; the average reduction announced by forty-five companies is 15 per cent.

The National Automobile Chamber of Commerce reports that production of passenger cars and motor trucks during the second quarter of the year was 87 per cent of the production figures for the corresponding period of 1920, which is a figure that will surprise a great many, and shows that the automobile business surpasses most other industries during this period of depression. Partly, this record is due to the high average maintained by the Ford factories, whose production schedule for August called for 117,800 cars and trucks from all the plants owned by the corporation. This is the highest production for any one month on record. The Buick, Hupp, White, Chandler, Jordan, and Dodge plants also report increased production, while the Willys-Overland reduced its August schedule and is laying off men. The Akron tire industry is reported operating practically on the 1918 level, which is considered normal.

Machine Tool Exports

The exports of machine tools during June, 1921, the last figures published by the Bureau of Foreign and Domestic Commerce, amounted to $460,000 as compared with $2,370,000 in June, 1920. Perhaps the most noticeable falling off in machine tool exports is to England, the June exports this year amounting to only about $28,000. It was $560,000 for June a year ago. Belgium took $60,000 worth of machine tools in June, 1920, and only $2,000 during the same month this year. The exports to Canada show a very decided falling off, amounting to over $44,000 in June, as against $101,000 in April, this year, and $410,000 in June, 1920. Mexico remains a good customer, taking nearly $50,000 worth of machine tools in June, France following closely with a similar amount. Japan heads the list with nearly $75,000, and China more than $25,000 worth. In May there was an unusually large shipment of machine tools to the Dutch East Indies, amounting to nearly $60,000.

Compared with 1913, the value of the exports of metal-working machinery (statistics prior to 1918 include machine tools under that general heading) in May, 1921, was at the rate of 110 per cent of the average monthly shipments of metal-working machinery in 1913; 145 per cent of the average shipments in 1912; 182 per cent of the average shipments in 1911; and 295 per cent of the average shipments in 1910. This indicates that present exports are low only when compared with the unusually large volume during and immediately after the war.

Labor Conditions

The announcement has been made that the Erie Railroad has leased its shop at Marion, Ohio, to a private company which can operate it without being bound by the labor union rules governing the railroad shops. This may prove to be the only way in which efficiency can be attained in locomotive repair shops, for it is only too well known that irrespective of the wages paid, these rules have increased costs. Union wages will be maintained in the shops operated by the private company, but the work and methods will be in accordance with the best manufacturing practice and free from rules which reduce efficiency without in any way benefiting the worker.

The building of small homes is brisk in many sections of the country, and wherever new wage arrangements have been made with the labor unions, increased activity is also noticeable in the construction of office and factory buildings. Employment in fourteen major industries reported upon by the Federal Reserve Bank in the New York district indicates improved employment conditions in nine industries, stationary conditions in two, and decreased employment in three industries—the iron and steel, car building and repairing, and paper-making.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

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Garrison Gear Grinding Machine

AN automatic machine for generating and grinding the involute profiles of spur gear teeth has been placed on the market by the Garrison Gear Grinder Co., of Dayton, Ohio. Gears which have previously had their holes hardened and ground and been roughed out on a gear-cutting machine leaving a grinding allowance of from 0.008 to 0.012 inch on the tooth thicknesses, are mounted on the work-spindle of the gear grinding machine and have the teeth generated and ground to the correct form and size. This operation takes about the same time required for taking a finishing cut on a gear-cutting machine. The grinding wheel is dressed on both sides to the pressure angle of the teeth and to the correct thickness. It is traversed back and forth through the gear tooth spaces by means of a ram.

The gears being ground are indexed one tooth after each stroke and fed toward the wheel slightly after each revolution of the latter, thereby accomplishing the generation of an involute. The gears are rotated slightly each time the table is fed over, through a hardened and ground master gear on the outer end of the spindle and a master rack.

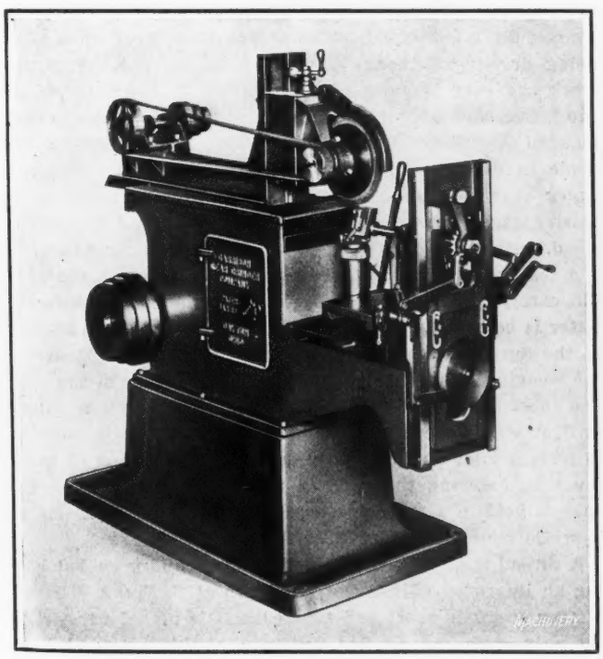


Fig. 1. Automatic Gear Grinding Machine developed by the Garrison Gear Grinder Co.

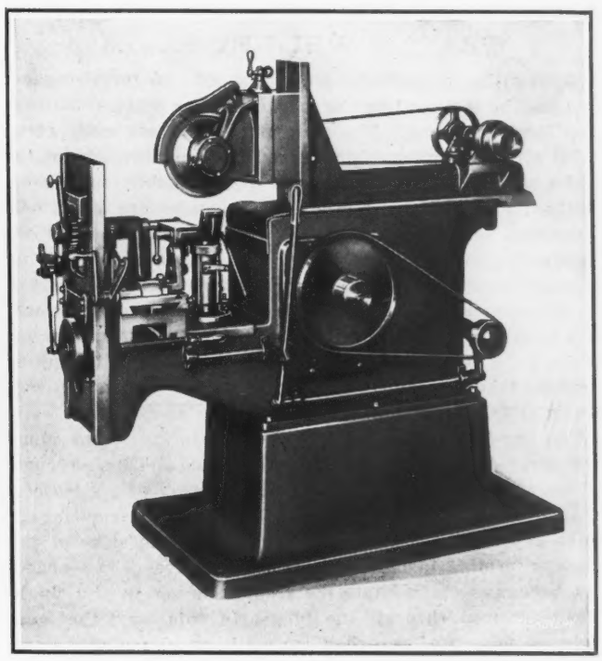


Fig. 2. View of Right-hand Side of Garrison Gear Grinding Machine

By this arrangement a new tooth surface is presented to a new surface on the grinding wheel after each revolution of the wheel. This prolongs the accuracy of the wheel by distributing the wear over a comparatively large area. As the master rack is meshed with the master gear at all times when the grinding wheel is in contact with the work, an accurate spacing of the teeth is insured. Any given tooth is not touched a second time by the grinding wheel until the gear has been indexed through a complete revolution; in this way, the generation of heat in the gears being ground is avoided.

The machine is so designed that after being adjusted for grinding a gear of given dimensions, an unskilled operator can run several of them on gears having as few as twelve teeth, and more machines in proportion to the number of teeth. No adjustment of the grinding wheel is necessary subsequent to dressing, and so, after the dresser is once set for truing a wheel to grind a certain size gear, the wheel may be dressed repeatedly without any change in the size of the gear teeth. The wheel is fed downward for the dressing step, diamonds being used for this operation. All feeds and the stopping of the machine at the completion of an operation, are automatic. It is not necessary to stop the grinding wheel in order to load or unload the machine as the work-table can be moved over to eliminate interference. The machine is suitable for grinding gears of from 2 to 9 inches in pitch diameter and any number having a combined width of 3 inches or less. It is adapted for grinding wheels of from 6 to 10 inches in diameter. The machine complete with a countershaft weighs approximately 1500 pounds.

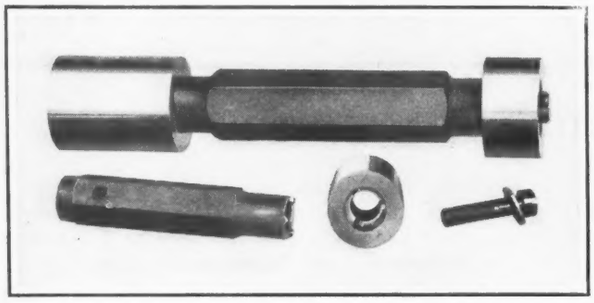


Fig. 1. Assembled and Disassembled Plain Plug Gage made by the Pratt & Whitney Co.

PRATT & WHITNEY GAGES

A new line of palin and thread plug and templet gages has just been placed on the market by the Pratt & Whitney Co., Hartford, Conn. The plain plug gages are made of an alloy steel and are machine-lapped by a modification of the Hoke process which results in a finely finished surface entirely free from circular grooves. The gages are of uniform size from end to end to such a degree that no errors are shown by measuring machines, fluid gages, or amplifying gages. The ends are reversible and their sizes are marked on them instead of on the handle. The "Go" ends are held to a small plus limit from the marked size to allow for wear, while the "Not Go" ends are held to a still smaller minus limit as they are subject to little wear. All blanks are well seasoned before lapping.

The handles are made of hexagonal stock and the plugs are secured to them by a novel method. Three prongs, whose sloping sides form an included angle of 90 degrees, are provided on each end of the handle; these prongs engage three grooves machined in the gage ends, the sides of the grooves forming included angles of 75 degrees. The wedge-like prongs are forced into the grooves by means of a single screw inserted through the plug. In this way, the gage ends are so secured that they can neither rock nor shake and so destroy the sensitiveness of the "feel." The head of the screw used in attaching the "Go" end to the handle is below the surface of the plug end, while the head of the screw on the "Not Go" end projects slightly. This design insures that the gage will always be in an upright position with the heavier end down. All sizes of handles are made in either the single- or double-end design. A hole is provided through the handle to permit of hanging the gage on a nail when desired, and if the gage becomes fast in work being inspected, a file tang or some other suitable object may be inserted in the hole and used to free the gage. These gages are now made in various sizes ranging from 5/16 to 2 inches in nominal diameter, but smaller and larger sizes are made.

The various styles of thread gages shown in Fig. 3 are made from the same alloy steel blanks as the plugs of the gages just described. The "Go" and "Not Go" ends are made interchangeable with the plugs and either length can be used according to a customer's preference. Short gages are particularly recommended for threads of fine pitch. The gages are secured to the handles in the same manner as the plug ends, so that the same rigidity is obtained and the sensitiveness of touch is not lost. The gages shown at *A* and *B* are single- and double-ended, respectively. That shown at *C* is a protected master gage, so called because it is impossible to screw it into a hole and thus impair its accuracy. It is used as a standard for checking thread plug gages by means of a measuring machine, micrometer, etc. The gage shown at *D* is used for setting thread gage templets, the threaded end being a duplicate of the thread in the templet, while the plain end is used for checking the root diameter.

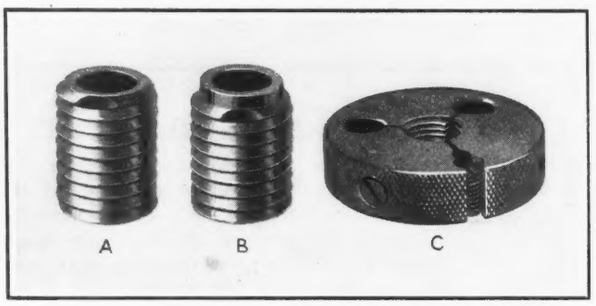


Fig. 2. (A) and (B). Gage End Details showing Chip Groove and Pilot. (C) Adjustable Thread Templet Gage

The gage shown at *E* is a non-reversible thread plug gage. This style is used for sizes ½ inch in diameter and smaller and for larger sizes where the reversible feature is not desired. The surfaces of the handle and thread plug in contact are tapered and so the parts cannot work loose after being driven together. Where the limits specified on the work are very large, extreme accuracy is not required of the gages, and so working gages made to tolerances recommended by the National Screw Thread Commission are made in different forms and sizes for such work. These gages have the same appearance and wearing qualities as master gages, but are not lapped, being ground to size instead, with an allowance of about 0.0005 inch for wear.

A feature of the plug thread gages is the groove provided for carrying dirt and chips ahead of the gage when the latter is being entered into a hole. This groove may be seen at the top of the thread plug shown at *A*, Fig. 2. It avoids the wedging of dirt or chips between the threads of the gage and those of the work. A modification of this style is shown at *B*, in which the first convolution of the thread is removed to form a pilot of the root diameter. This pilot is of assistance in entering the gage in running work or when the gage is held in a reversing speed lathe and the work fed to it while running.

A thread templet gage of the familiar round type, but having an improved adjustment, is shown at *C*, Fig. 2. The adjusting screw is short and tapered and is placed parallel to the axis of the gage. One full turn of this screw changes the effective diameter of the gage about 0.001 inch, and adjustments finer than 0.0001 inch can be made. The first thread of the templet is chamfered to the angle of the thread

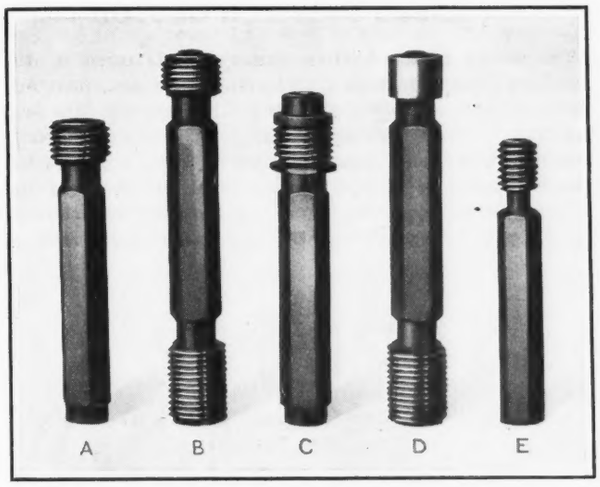
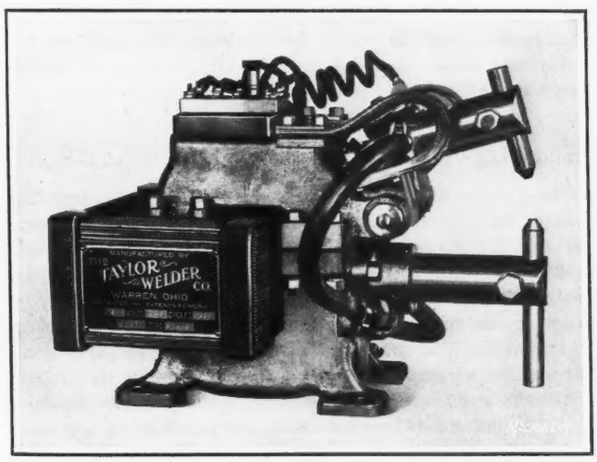


Fig. 3. Various Styles of Thread Plug Gages, with Reversible Ends on All but One

for ease in starting. The chip groove of the thread plug gage can be furnished on the templet gage but this is not usually necessary because a male thread can be more readily cleaned than the threads of a tapped hole, and moreover, the slots in the templet provide chip space.

TAYLOR BENCH SPOT WELDER

The type S-4-B bench spot welder now being built by the Taylor Welder Co., 12 Atlantic St., Warren, Ohio, is shown in the accompanying illustration. This machine is recommended for spot-welding sheet metal of light gage, cross-wire welding, welding contact points of platinum or tungsten to steel, and brazing and soldering small parts of electrical instruments, optical goods, etc. A special feature of this machine is the cast-copper frame which acts as a secondary. The lower horn may be set at three different heights on the

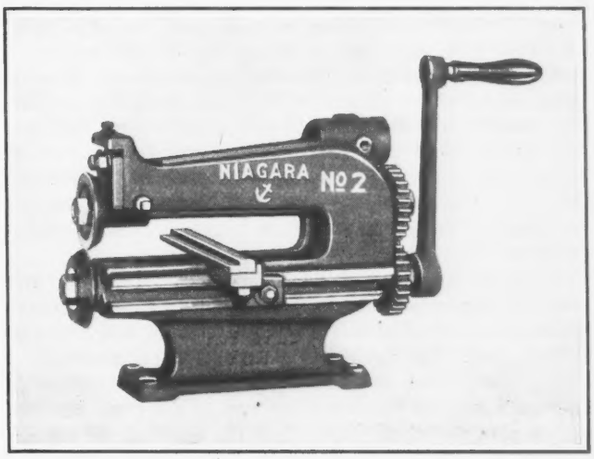


Bench Type Spot Welder built by the Taylor Welder Co.

frame to suit the work, by the provision of different sets of holes. A long electrode is provided on this horn to suit the various settings. Cooling of the machine is accomplished by the circulation of water in the upper and lower horns. The horns are made of cold-drawn copper and are 1¾ inches in diameter. The greatest movement of the upper electrode is 1 inch and when this electrode is lowered the minimum distance between the horns is 3 inches and the maximum, 5 inches. The machine is operated through a foot-pedal. One set of solid points is furnished with each machine and the weight of the latter is approximately 150 pounds. The machine is equipped with a 3-kilowatt transformer and a 4-step regulator for adjusting the current. The switch is of the automatic single-pole type.

NIAGARA ROTARY SHEAR GAGE

The Niagara Machine & Tool Works, Buffalo, N. Y., recently obtained a patent on a slitting gage that is being applied to rotary sheet metal shears. The accompanying illustration shows a hand slitter equipped with the gage. The gage consists essentially of a bar extending transversely through the gap of the machine and against which one edge of a sheet bears so that it is cut to the required width. The bottom of the transverse bar rests upon the frame of the machine and is connected at the ends to sliding blocks. These blocks may be clamped in any predetermined longitudinal position along the machine so that the distance from the rotary knives to the gaging bar may be altered to suit a job. They are clamped on machined surfaces of the frame by means of T-bolts. The only member of the gage subject to wear is the transverse bar, and this can be readily replaced, as it is located on the sliding blocks by means of

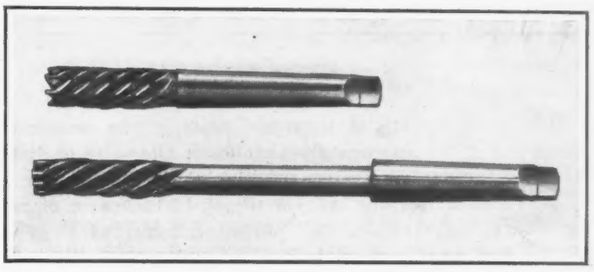


No. 2 Slitter equipped with Gage patented by the Niagara Machine & Tool Works

dowels and attached by bolts. The gage can be removed from the shear when it interferes with such operations as circle or ring cutting.

GAMMONS-HOLMAN END-MILL AND CHUCKING REAMER

The Gammons-Holman Co., Manchester, Conn., has introduced on the market the new types of end-mills and chucking reamers shown in the accompanying illustration. The end of the cutting portion of both tools is made in the usual way while the body is provided with helical cutting edges, the "hand" of the helix being opposite to that of the tool. That is, the chucking reamer and right-hand end-mill have left-hand helical cutting edges while the left-hand end-mill has right-hand helical cutting edges. It is stated that the helical body counteracts the tendency of the straight-fluted end to chatter, with the result that the reamer produces a true smooth hole and the end-mill leaves the surface it mills so smooth that further finishing is unnecessary. There is no chatter of the tools in use.



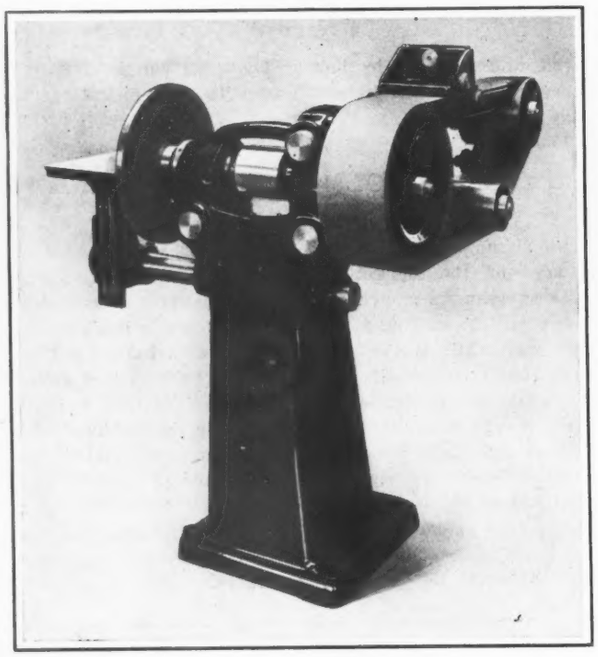
End-mills and Chucking Reamers placed on the Market by the Gammons-Holman Co.

GRINDING AND POLISHING MACHINE

A combination machine designed to handle the work of a disk grinder, a polishing wheel, and a belt-surfacing machine and which, in addition, can be converted into a double-spindle buffing machine or into a light snagging grinder has been developed by the Production Machine Co., Greenfield, Mass., and is known as the "Type R." This machine is adapted for a wide range of work, and the construction is such that three operators may work simultaneously without interfering with one another. The base and head are cast integral, so as to supply the necessary rigid support for the spindle and its bearings.

The spindle is equipped with Timken roller bearings, and these are packed in grease and sealed from dust. On one end of the spindle is mounted a double-faced disk grinding wheel, and on the other end, a patented leather cushion wheel over which an abrasive belt runs. This wheel, together with the belt, is used for a variety of polishing operations. The belt is 6 inches wide, endless, and kept under the proper tension by means of a swinging idler pulley. A table is furnished for use in surfacing operations, and this is equipped with an adjustable rest that facilitates the handling of articles having straight or angular edges. This rest is so hinged that it may be quickly swung over the back of the machine when it is necessary to change the abrasive belt. The idler arm is arranged with a latch, so that the idler may be lifted off the belt and held in a raised position while the latter is being changed.

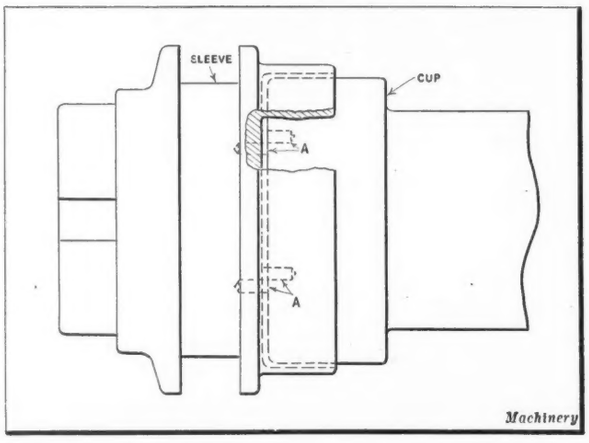
The double-faced disk wheel is reversible. A table is provided for supporting work being ground on this wheel, the table having a rocking seat which enables the supporting of angular work. The table has a vertical adjustment and a circular adjustment on the holding post. The machine is equipped with four holding posts, two in the front and one on each side, and these posts adapt the machine for the application of a variety of fixtures. Some of the principal dimensions of the machine are as follows: Diameter of disk wheel, 15 inches; dimensions of disk-wheel table surface, 9¾ by 8 inches; leather cushion wheel, 14 inches in diameter and 6 inches wide; and surfacing table, 14 by 6½ inches. The spindle speed is 1300 revolutions per minute, and the surface speed of the abrasive belt, 4760 feet per minute.



Combination Grinding and Polishing Machine developed by the Production Machine Co.

JOHNSON FRICTION CLUTCH

The design of the friction clutch manufactured by the Carlyle Johnson Machine Co., Manchester, Conn., has been modified to incorporate a positive locking feature. The load can only be started under friction, but when the clutch is completely engaged it becomes positively locked and so the driven member is rotated constantly at the speed of the driver without any possibility of slippage, due to variations in the load or to other causes. The clutch is operated by an outside shifter sleeve, which carries a sliding wedge between two toggle levers that expand a friction ring and cause the latter to grip the opposing surface of a cup member. On the faces of the cup and shifter sleeve are six pairs of opposing pins *A* spaced equidistantly around a circle. When the clutch is disengaged, both frictional surfaces and the opposing pins are out of engagement. However, as the shifter sleeve is thrown in, the frictional surfaces begin to take the load and practically carry it at full speed before the opposing pins come into contact with one another. Then, the full throw of the clutch having been accomplished, the pins are in engagement so that the clutch drives as a positively locked unit.



Friction Clutch with Positive Locking Feature, manufactured by the Carlyle Johnson Machine Co.

THERMIT-WELDING MOLDING MATERIAL

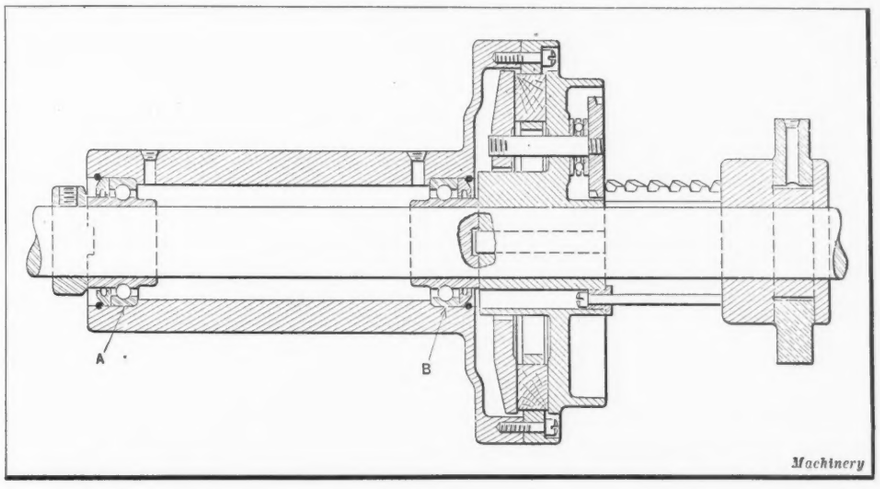
A new grade of molding material for thermit-welding has recently been brought out by the Metal & Thermit Corporation, 120 Broadway, New York City. It is stated that this material prevents blow-holes, stands up well under the preheating flame, and is extremely porous to the gases generated in the mold so that a sound weld with a clean exterior results. The mixture is composed of three parts clean sharp silica sand to one part of Welsh mountain plastic clay. The sand must pass through a screen of 0.03 inch square mesh, and 40 per cent must be retained on a screen having 0.012 inch square openings. In using the material, the sand and clay are thoroughly mixed together with 1/40 part "Glutrin" compound and sufficient water to bring the mixture to the proper consistency.

HILLIARD CLUTCHES AND COUPLINGS

The line of sleeve clutches made by the Hilliard Clutch & Machinery Co., Elmira, N. Y., is now being equipped with Fafnir ball bearings as shown at *A* and *B*, in order that the clutches may be satisfactorily used for high speeds up to 2000 revolutions per minute. The bearings are of the annular type and are fitted with caps provided with felt washers that exclude dust and retain the lubricant. The use of the ball bearings insures that the sleeve member will be kept in the proper alignment with the member

keyed to the shaft, and that the frictional surfaces will always be in the proper plane with each other.

The friction cut-off couplings made by the same concern, for directly connecting centrifugal pumps, generators, and blowers to gasoline or electric motors are now furnished with a Fafnir ball bearing for the pilot. The driving member of the coupling is very similar to that of the clutch illustrated. Provision of the ball bearing in the coupling insures the proper alignment between the driving and driven shafts and satisfactory lubrication. Both the cut-off couplings and the friction clutches are made for shafts of various diameters from 1 3/16 to 3 15/16 inches.



Ball Bearing Modification to the Sleeve Clutch made by the Hilliard Clutch & Machinery Co.

GENERAL ELECTRIC CONTROL FOR DIRECT-CURRENT MOTORS

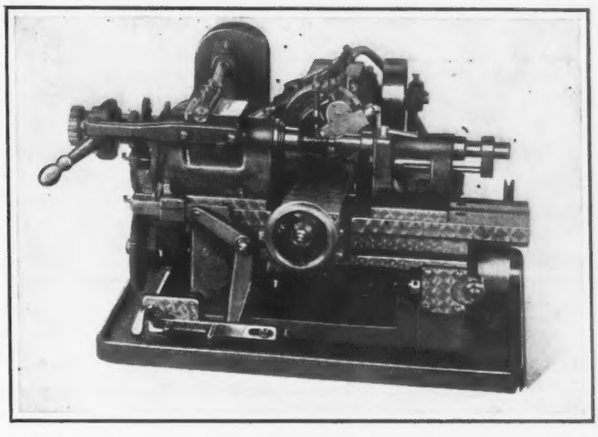
A type of control for direct-current motors of either reversing or non-reversing applications, which is a combination of time and current limit, allows high torque when necessary and minimizes current peaks on light loads, has been designed by the General Electric Co., Schenectady, N. Y. This control system is known as the "voltage drop," being so named from the fact that the relays controlling the accelerating contactors are operated by the voltage drop across the starting resistor of the motor. A current limit system of some sort is considered best for motors subjected to frequent starting and stopping and which are required to operate under varying conditions of torque. Such conditions include applications where the motor is required at infrequent intervals to accelerate loads as high as twice normal, and should be protected from such high current peaks the remainder of the time. This system uses an improved form of shunt contactor and is applied to standardized panels for the control of various types of motors.

WALTHAM AUTOMATIC THREAD MILLING MACHINE

The Waltham Machine Works, Newton St., Waltham, Mass., are now manufacturing an automatic thread milling machine which is intended for manufacturing purposes and is so designed that it may be equipped for a large variety of work. After the work has been placed in position either on centers or in a chucking device, the machine is started by raising a lever at the left end. The feeding of the cutter into the work to the required depth, the milling of the thread, the withdrawal of the cutter after the required length has been milled, the returning of the cutter to the starting point, and the stopping of the machine are wholly automatic. These automatic features enable a number of machines to be handled on some kinds of work by one operator. With multiple threads the operation is continuous until all threads have been milled, so that for a triple thread the cutter would engage the work for its entire length, three times before the machine would stop.

The length of a thread cut by the machine corresponds to the amount of rise on the cam that controls the work-slide, and its pitch is governed by the relation between the gearing from the work-head to the camshaft, and the lead of the cam. The indexing for multiple threads is obtained by a fractional proportion in the gearing and as the work-head revolves continuously there is no backlash to cause inaccurate spacing. The maximum travel of the work-slide is 2 inches, and threads of this length or shorter may be milled. Adjustments enable the milling to be done either close to the work-spindle or in any position not more than 6 inches distant. The approximate locating of the cutter-slide relative to the work-head is obtained by moving the support of the cutter-slide along tongued ways, while the exact location is obtained by adjusting the work-slide cam-shoe attached to a slide at the front of the machine. An angular adjustment of 45 degrees each side of the horizontal is provided for the cutter-head. A special high-speed cutter-head is provided for brass work.

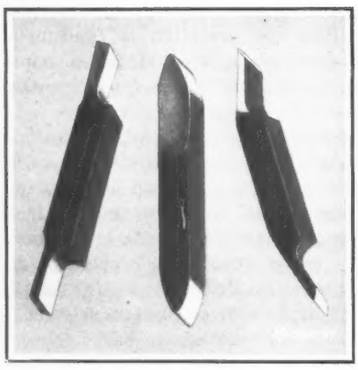
A single belt drives the entire mechanism with the exception of the oil-pump. This is separately driven and pumps oil from a reservoir in the base upon which the machine is mounted. The work-spindle is made of hardened steel; it has a spring collet and is equipped with a lever-closing attachment. The mechanism for automatically stopping the machine can be adjusted to function at the end of one cam revolution or after any predetermined number of revolutions necessary for the cutting of multiple threads. The machine can be modified for cutting helical gears. It may be installed either on a bench or a cabinet base.



Automatic Thread Milling Machine developed by the Waltham Machine Works

DUPLEX CUTTING-END TOOL BITS

A line of tool bits of various sizes and shapes and having cutting edges ground on both ends, has been introduced by the New England Tool & Machine Co., Inc., 51 Taylor St., Springfield, Mass. A few styles are shown in the accompanying illustration. These bits are intended for being held

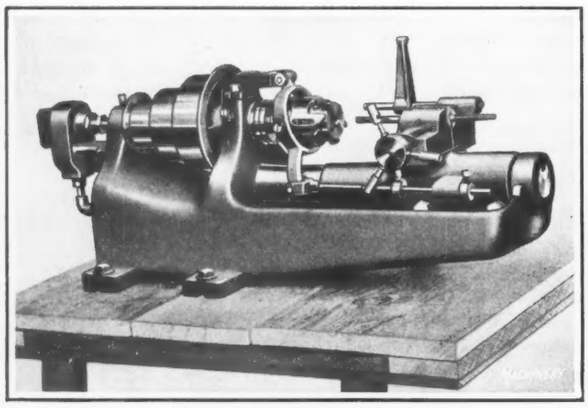


Tool Bits made by the New England Tool & Machine Co., Inc.

in tool-holders taking square stock, are cut from annealed bars of high-speed steel, and are hardened and ground. Their size permits them to be checked out from tool-cribs the same as drills and other tools, so as to reduce their loss. The line includes bits of the following styles: Right- and left-hand diamond point, right- and left-hand side, round nose, U. S. standard thread of all pitches, V-thread and cut-off. The sizes listed are from 3/16 to ½ inch square.

GEOMETRIC BENCH THREADING MACHINE

A bench threading machine equipped with a Geometric rotary die-head for the cutting of fine-pitch threads of from 1/16 to 5/16 inch in diameter is here illustrated. This machine has just been introduced by the Geometric Tool Co., New Haven, Conn. The bed consists of a single casting and has a spindle mounted in bronze bearings. This spindle is driven through a three-step cone pulley and carries the rotary die-head at its inner end. The die-head is operated by a yoke lever and trip-rod. Adjustable stops conveniently arranged on the trip-rod govern the opening and closing of the die-head. It is opened with a forward movement of the carriage and closed with a backward movement.



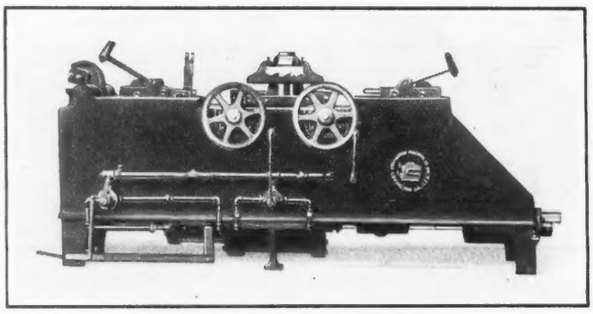
Small Bench Threading Machine recently brought out by the Geometric Tool Co.

The carriage is equipped with a two-jaw chuck operated by a handwheel, but collets, expanding arbors, or special holders can be furnished when the work requires such accessories. An adjustable swinging stop on the side of the chuck enables the accurate setting of work for the cutting of a thread to a predetermined length. The carriage is mounted on a round bar on which it is guided by a large bronze key that engages a keyway on the bar. An adjustment is provided for maintaining the proper fit of the carriage on its support. This construction facilitates the removal of chips from the bed of the machine. Oil from the reservoir in the bed is forced through the spindle and against the work by a geared pump having a direct drive from the spindle. The cone pulley furnishes proper spindle speeds for the rated capacity of the machine.

Different sets of chasers are required to cover the threading range of the machine and these may be readily removed from their slots after the die-head has been tripped and the stop plunger pulled out. Identification numbers are placed on the chasers and on their corresponding slots to insure the correct assembly of the chasers. This machine is arranged for bolting to a bench, or it may be mounted on a separate pedestal for floor use. Some of the specifications are as follows: Maximum length of thread which can be cut at one setting, 3¼ inches; with resettings, 18 inches; bench space required, 9½ by 29 inches; floor space required when mounted on pedestal, 16 by 29 inches; weight without pedestal, 90 pounds; and with pedestal, 175 pounds.

COVINGTON HOSE DISMANTLING AND ASSEMBLING MACHINE

A new development of the Covington Machine Co., Inc., Covington, Va., intended for use in railroad shops, is a machine for dismantling and assembling air-brake, signal and steam hose. It is claimed that with this machine no damage



Railroad Shop Machine developed by the Covington Machine Co., Inc.

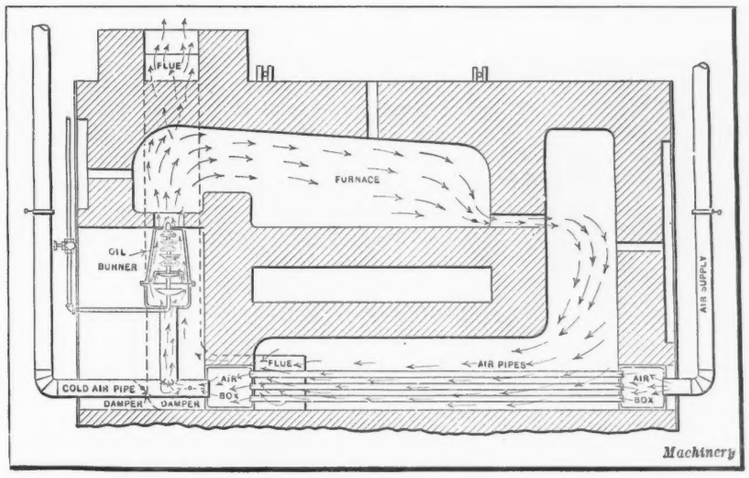
can be done to fittings and that a much better assembling job is accomplished than when the operation is performed by hand. On a test, one man dismantled one hundred pieces of air-hose in an hour and assembled twenty-five ready for service in another hour. The changing of the tools used in one operation for those of another averages less than two minutes. Air and signal hose are handled by the same tools except the nipple puller, and the latter can be put in place within ten seconds.

SILBERBERG TIME-STUDY WATCH

A time-study watch designed for the timing of from one to ten operations, up to and including five minutes' duration, has been developed by the Mortimer J. Silberberg Co., 122 S. Michigan Ave., Chicago, Ill. This instrument has three circles of numbers on the face of the dial, those of the outer circle being red, the middle circle, black, and the inner circle, blue. The large hand makes a total revolution in 100 seconds and the small hand near the center moves over red, black, and blue sectors to show which circle of numbers the large hand is indicating.

Duration Time-study Watch brought out by the Mortimer J. Silberberg Co.

All figures on the dial denote production per hour based on the timing of ten operations at one



Forging Furnace Installation of Oil-burner developed by the Pittsburg Saw & Mfg. Co.

time. For instance, if one operation requires twenty seconds, the figure under the large hand in the red circle of numbers is 1800, but as this figure is based on ten operations being performed at one time, it is necessary to divide the number by 10 in order to find the total number of operations per hour. The result would be 180.

If the duration of an operation is 130 seconds, the large hand will have made a total revolution plus a partial revolution to the 30-second graduation. In the meantime, the small hand near the center of the dial will have passed through the first sector and indicate the second or black sector, thus denoting that the number of operations per hour should be read in the black circle of numbers. The figure in that circle of numbers beneath the large hand when the latter indicates the 30-second mark, will be 277, this again being for ten operations.

The instrument has a feature which permits an operator to start and stop the watch without returning the large hand to the zero graduation. When an operation is entirely completed, all hands are returned to the starting point by pressing down the crown of the watch. The dial is divided into half-seconds.

PITTSBURG OIL-BURNING APPARATUS

In some cities it is common practice to shut off the supply of natural gas to industrial consumers in the event of a shortage, in order that domestic users may have a sufficient supply. To meet such a contingency the Pittsburg Saw & Mfg. Co., 32nd and Smallman Sts., Pittsburg, Pa., is placing on the market the A.G.S. oil-burning apparatus which has industrial and domestic applications. The burner is of the gasification type. In the metal-working field it is especially suitable for forging furnaces and core-ovens. A forging furnace installation is shown diagrammatically in the accompanying illustration. The furnace is 4 feet wide, 8 feet long, and 5 feet high. Air may be supplied to the burner by a small fan or blower, and arrangements have been made in the furnace for the exchange of heat between outgoing hot gases and incoming fresh air. The imparting of heat to the incoming air contributes materially to the efficient use of the fuel and makes possible the attainment of high temperatures in the heating chamber.

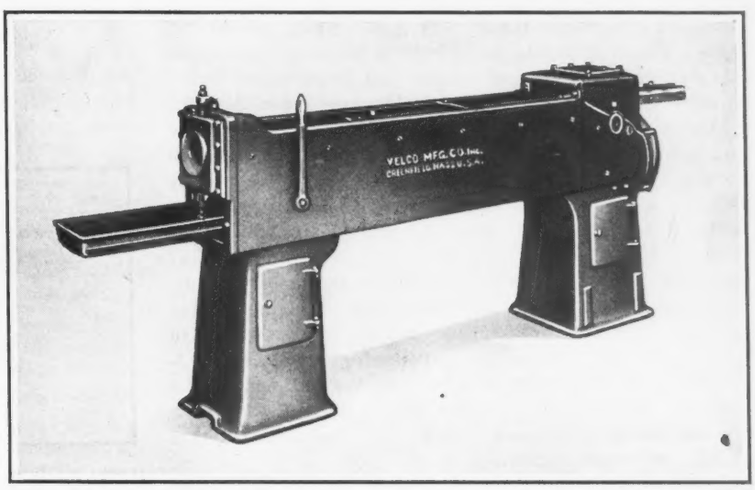
At no time has the temperature of the flue gases at a point six inches above the furnace been in excess of 650 degrees F., while temperatures of from 2600 to 2800 degrees F. have been maintained in the heating chamber. The consumption of oil in heating the furnace varies from 5 to 6 gallons per hour, and the time required is from 1 to 1½ hours. After the furnace has been raised to the desired temperature, the oil consumption necessary to maintain the temperature varies from 2½ to 3 gallons per hour. The oil used with this furnace must be free flowing at 32 degrees F., must have a flash point higher than 150 degrees F., must have less than 5 per cent residue at 700 degrees F., and must have a viscosity less than 100 Saybolt at 100 degrees F. Kerosene, mineral seal, mineral seal substitute and distillate, etc., can be used in connection with the burner. It is stated that the oil is consumed without producing smoke or odorous vapors. The installation of the burner is easy and its operation simple.

VELCO NO. 4 HIGH-SPEED BROACHING MACHINE

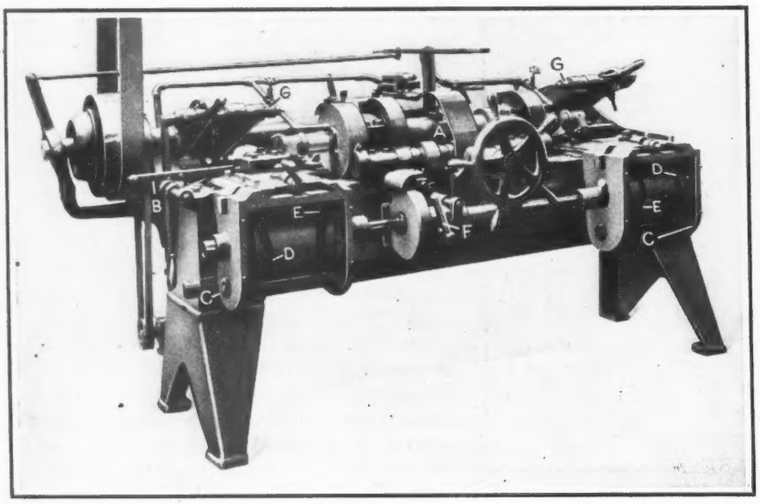
A heavy-duty high-speed broaching machine having several novel features has been developed by the Velco Mfg. Co., Inc., Greenfield, Mass. This machine has a cutting stroke speed of 15 feet per minute and a return stroke speed of 55 feet per minute. The broach holder is attached to a solid steel head and this is supported throughout its travel by bronze gibbed bearings sliding on steel ways. Power is applied to a rack that meshes with a pinion cut integral with a heavy shaft. The broach is attached to this rack so that the pull comes directly on the pitch line of the rack teeth. All vertical adjustments are made at the faceplate.

Stub gear teeth are provided on the rack and driving pinion. The teeth of the rack are on the under side, and the sides of the rack are guarded to protect the operator from injury. All other moving parts are completely enclosed. The rack is held in proper mesh with the pinion by means of rollers placed at the sides of the pinion and guide bars fastened to the sides of the rack, thus making a rolling contact on the pitch line. The pinion-shaft is driven through a phosphor-bronze worm-wheel and a hardened steel worm which runs in oil. The worm-shaft is provided with ball thrust and radial bearings.

The rapid return stroke is accomplished by means of an internal gear cut on the worm-wheel. This internal gear drives the return gear shaft, the return motion being applied through the driving pinion. The driving clutch is not operated during the cutting stroke and so acts as a positive coupling. All parts are protected from shock due to the operation of a positive clutch under load.



No. 4 Heavy-duty High-speed Broaching Machine built by the Velco Mfg. Co., Inc.



Semi-automatic Automobile Axle-shaft Turning Machine made by the T. C. M. Mfg. Co.

In operating the machine, the belt is first shifted on the loose pulley to relieve the load from the clutches. A further movement of the shifting lever causes a friction brake to be applied to the driving pulley and withdraws the positive clutch. A still further movement of this same lever engages the reverse clutch and then shifts the driving belt on the tight pulley, thus reversing the machine. Automatic stops are provided and these are quickly adjustable and positive in action. Non-removable emergency stops protect the mechanism in the event that an operator neglects to set the automatic stops. A single lever conveniently placed regulates every motion of the machine, and the direction in which this operating lever is moved corresponds to the direction in which the rack will travel.

Coolant is supplied to the broach by a gear-driven pump of large capacity. A pan which telescopes into the bed catches chips and returns the fluid to the reservoir. The bed is of box section and is supported at the front and back ends by cabinet bases. A three-point suspension is a feature of this assembly. The front cabinet has storage space for small equipment. The maximum pulling effort of this machine requires 15 horsepower, but ordinary broaching operations may be accomplished with a 10-horsepower motor. The machine is furnished for either belt or motor drive, there being no difference in the construction for the two driving methods.

T. C. M. AXLE-SHAFT TURNING MACHINE

The accompanying illustration shows the front view of a semi-automatic machine built by the T. C. M. Mfg. Co., Hunterdon and First Sts., Harrison, N. J., for machining rear-axle shafts of the full-floating type for automobiles and trucks. These shafts are made from nickel or chrome-nickel steel forgings, and are heat-treated and straightened before any finishing is done. The machine squares the ends of the forgings to length, turns down each end to the correct diameter, bevels one end, turns and bevels a small projection on the other end, and finally centers each end. The centers are necessary for supporting the work in succeeding operations in which the ends are finish-ground and splines are hobbed.

A forging to be machined is placed in the hollow spindle *A* with both ends projecting. Two chucks hold the forging close to the portions to be turned, and the forging is located in these chucks by means of a positioning stop *B*, which is brought up by operating the lever at the left end of the machine. When not in use, this stop is lowered out of the way as shown. The two chucks are operated together through the large handwheel at the front of the machine and a differential which enables the chucks to be brought equally tight on each shaft end, irrespective of any variations in the diameters of the surfaces gripped.

The machine is provided with four slides *C*, two at the front and two at the rear, and each of these slides is provided with a cross-slide. The slides at the front carry the tools for turning the ends, while those at the rear are equipped with tools for facing the ends to length, cutting the small projection on one end and beveling both ends. The front slides make two movements across the work during each cycle of the machine, and the rear slides, three. The tools are advanced into the work before each traverse is made. The slide movements are obtained through cams *D*, which are provided at the front and rear of the bed, and which engage cam rollers set in the bed. The cross-slide movements are controlled by cams *E*. The variations in the diameter of the work are compensated for by screw adjustments.

When a forging has been clamped in position, the cam-operating shafts are started by operating trip-lever *F*. Then the four tools simultaneously move over the work, and when the cycle is completed, the tools stop clear of the surfaces which they have finished. The operator then swings down the drilling spindles *G* and drills the centers while the shaft continues to revolve. The finished shaft is ejected from the machine by an extension of the positioning bar *B*, which pushes the shaft sufficiently out of the chucks to permit the operator to lift it out. A gear-box at the rear of the machine provides three spindle speeds and three feeds to suit shafts of various diameters.

The hollow spindle is telescopic and the position of slides *C* at one end of the machine may be altered, so as to accommodate shafts of various lengths from 36 to 48 inches. The diameters may vary from 1¾ to 2¾ inches. To enable quick adjustments to suit different lengths of shafts, the adjustable slides and the corresponding drilling spindle and spindle bearing are connected by bars to a bracket which can be moved along the bed by rotating a screw at the right-hand end. Therefore, by loosening the clamping bolts and turning this screw, all the required length changes are made simultaneously. A pump supplies coolant to the cutters and these may be either of the circular-formed or solid-rectangular types. The machine is driven through a single belt and a clutch pulley. The time required for machining an axle-shaft averages from four to ten minutes, according to the diameter of the portions turned and the quality of the forging.

"DUMORE" PORTABLE AND BENCH DRILLS

A small portable electric drill, known as the Model 1-BD, having a capacity for drilling holes up to ¼ inch in steel and ⅜ inch in wood is shown in Fig. 1, while a similar drill, model 2-BD, of the same capacity, but mounted on a stand for bench use, is shown in Fig. 2. These drills are

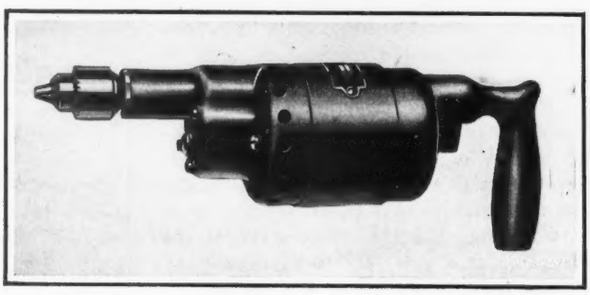


Fig. 1. Model 1-BD "Dumore" Portable Drill made by the Wisconsin Electric Co.

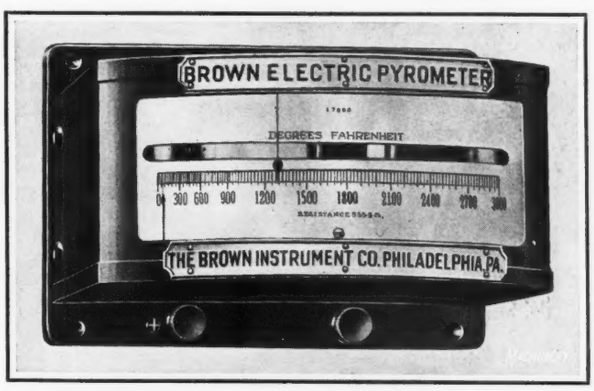
Fig. 2. Model 2-BD "Dumore" Drill

manufactured by the Wisconsin Electric Co., 2539 Sixteenth St., Racine, Wis. The drills are equipped with motors which operate on either direct or alternating current. The drill spindle is driven through helical gears made from steel and heat-treated. The surfaces on which these gears are mounted are ground to size.

The drill spindle is offset 31/32 inch from the center of the housing and runs in two self-aligning annular ball bearings. The column of the bench drill is nickel-plated and the overall height of the machine is 20½ inches. The feed is 3¼ inches and is obtained through a rack and pinion. The table is adjustable for height and may be swung to the rear when desiring to drill work resting on the base. Both drills are furnished complete with ten feet of cord, a plug, a switch and a No. 1 Jacobs chuck. The net weight of the bench drill is 21 pounds, and that of the portable drill, 5 pounds.

BROWN COLD-JUNCTION COMPENSATED PYROMETER

It is well known that the millivoltage developed by the thermo-couple of thermo-electric pyrometers is dependent upon the difference in the temperatures of the hot and cold ends of the thermo-couple, and in order to secure accurate measurement of temperatures the cold end should be maintained at a constant temperature or else the pyrometer should compensate for the changes of temperature at this junction. On the pyrometer illustrated, which has been developed and patented by the Brown Instrument Co., 4512 Wayne Ave., Philadelphia, Pa., such a compensation is automatically obtained. The pointer of the instrument can be set to zero in the usual manner.

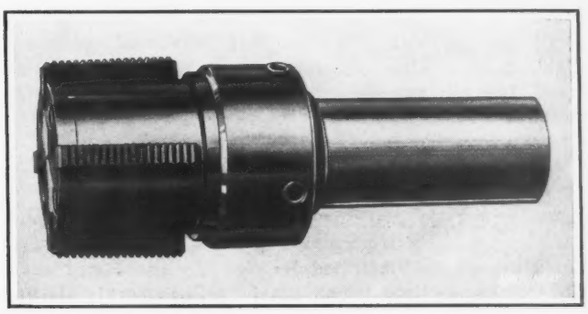


Improved Thermo-electric Pyrometer patented by the Brown Instrument Co.

It is common practice to use extension or compensating leads to transfer the cold junction from the binding posts of the thermo-couple to a distant point where a constant temperature can be maintained. With this pyrometer, however, the extension or compensating leads are brought to the meter as the changes in the temperature at the end of the leads also take place in the meter and can be compensated for. In using the pyrometer, the pointer is set by the zero adjuster to correspond with the index on the scale. If the values of a thermo-couple are based on a cold junction of 75 degrees F., the index will indicate that temperature, provided the atmosphere surrounding the instrument is of that temperature. If the instrument pointer does not correspond with this index, it is set accordingly. When the temperature of the atmosphere surrounding the instrument rises to 90 degrees F., the index automatically shifts to 90 degrees F. and the instrument pointer also moves to that graduation. Any number of thermo-couples with their extension or compensating leads can be brought to one instrument. Recording instruments can also be equipped with this automatic compensation.

GEOMETRIC ADJUSTABLE TAP

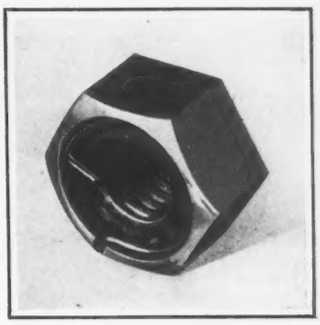
The accompanying illustration shows an adjustable tap which has been placed on the market by the Geometric Tool Co., New Haven, Conn. This tap does not have a collapsing device, as it is intended for use on machines that are not provided with a means of closing collapsible taps. The chasers are easily removed for regrinding, and as they are adjustable, the correct size of the tap can always be maintained. Each size of tap accommodates chasers for a range of diameters, and when the chasers become worn, they can be renewed at a small cost, as compared with the cost of a new tap.



Adjustable Tap made in Various Sizes by the Geometric Tool Co.

THIBERT SELF-LOCKING NUT

The new type of self-locking nut shown in the accompanying illustration is made in all sizes from ¼ to 1 inch, and with either S. A. E. or U. S. form threads. This nut has been introduced recently by the Industrial Lock Nut Co., 306 Main St., Worcester, Mass. The locking member consists of a circular wire spring, one end of which projects outward and the other, inward. The outer face of the nut is counterbored and recessed to receive this spring, and the latter is forced to turn with the nut due to the outwardly projecting end engaging a groove cut on the nut face. The other spring end engages the thread of the bolt or part on which the nut is screwed, and although it does not interfere with screwing the nut in place, it prevents the nut from being loosened by vibration.



Thibert Self-locking Nut sold by the Industrial Lock Nut Co.

PRATT & WHITNEY SCREW PLATE SETS

The Pratt & Whitney Co., Hartford, Conn., is now marketing screw plate sets made up from their regular line of products, for cutting either U. S. standard, S. A. E. or Whitworth threads. These sets are sold in various combinations to suit the requirements of small shops, garages and toolrooms, and are packed in nicely finished and suitably

One of the Screw Plate Sets now being sold by the Pratt & Whitney Co.

marked cases. They may be furnished with either plug or taper taps, or both. The set here illustrated consists of eighteen taps, nine adjustable round split dies, one diestock, two tap wrenches, and a screwdriver for adjusting the dies.

STOLP LOCK-SEAMING MACHINE

An automatic machine for bending and lock-seaming sheet metal parts from strips or coils of stock by a patented process is illustrated in Fig. 1, while Fig. 2 shows some of the sections which can be formed. This machine is a recent development of the Stolp Co., Inc., Geneva, N. Y. The machine is equipped with a self-feeding attachment. The stock, on being fed into the machine, is first pressed into a U-shape by a punch, after which a round mandrel enters the blank from the rear and pushes it endwise through lock-seaming dies. The mandrel is fastened to a crosshead connected to a chain. This chain runs continuously and carries the crosshead back and forth the entire length of the frame.

As the mandrel reaches the farthest back position, the U-shaped punch descends and presses the blank into a position in line with the mandrel. The mandrel enters the blank as the punch leaves it and carries the work forward as

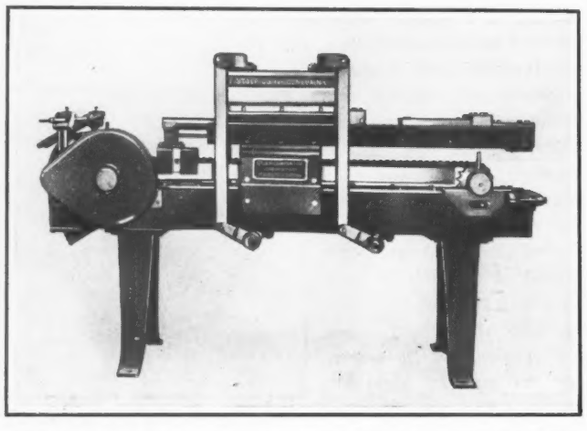


Fig. 1. Automatic Lock-seaming Machine patented by the Stolp Co., Inc.

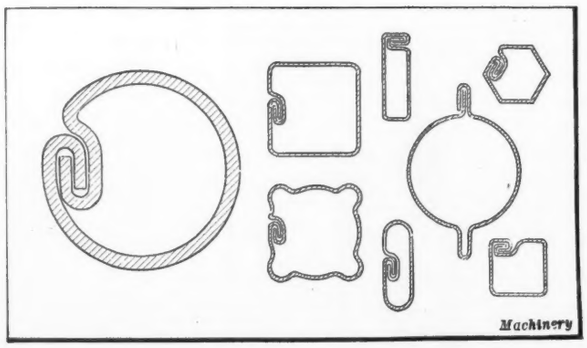
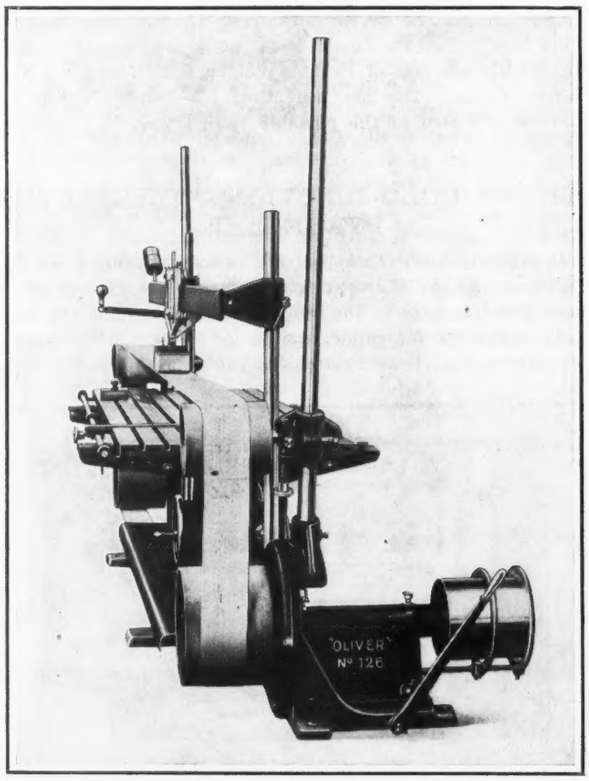


Fig. 2. Various Tube Sections formed on the Lock-seaming Machine

previously explained. The lock-seaming dies have no moving parts, but they are so constructed that the blank is closed and the lock-seam produced in one operation. The machine will lock-seam taper tubes within certain limits. Among the many parts which can be produced on this machine are tubes for automobile mufflers and radiators, blowers, and ventilators.

OLIVER UNIVERSAL BELT SANDER

A No. 126 universal belt sander has just been brought out by the Oliver Machinery Co., Grand Rapids, Mich., for the rapid sanding and polishing of line and edge moldings, patterns and various other parts made from wood. It may



No. 126 Universal Belt Sander built by the Oliver Machinery Co.

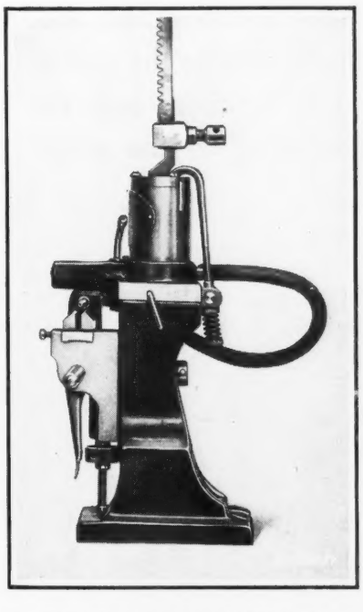
also be used in the polishing of metals. The abrasive side of the sand belt is in contact with the pulley faces. In addition to the safety features obtained by this arrangement, the breaking of sand from the belt is avoided and so the longevity of the belt is increased. The table rolls on ball bearings and is so easily moved that a slight push causes it to roll the full travel of 36 inches. This construction is covered by a patent. The table top consists of plain wooden strips, spaced one inch between each strip. The different gaps allow any dust which may accumulate to drop through

the table, and thus serve to keep the top clean. The table is 36 inches wide by 96 inches long and is provided with an adjustable bar to hold the work.

Means are provided for taking up slack of the sand belt so that a suitable tension for the work in hand may be obtained. An idler is supplied for this belt and this idler is adjustable up and down to the height of the work. It can also be placed in a tilted position to prevent the belt from running to either side of centers. An attachment is furnished for the power stand arm for use in sanding edge work. This attachment has an adjustable table that can be tilted 45 degrees up or down and raised or lowered to suit conditions. Attachments are also supplied for sanding edge moldings and irregular shapes, and the machine may be arranged either with or without a sanding pad attachment. The machine may have a motor drive or it may be driven by belt from a roller-bearing countershaft. The machine will sand to a center of 72 inches, and will take work on the table up to 54 inches in height and on the floor plate, up to 72 inches in height. The table has a vertical adjustment of 14 inches, and sanding belts up to 10 inches in width may be used. The machine occupies a floor space 72 inches wide and any preferable length. The over-all height is about 80 inches, and the weight, approximately 1400 pounds.

CAULKINS AUTOMATIC DRILL JIG

An improved automatic drill jig designed especially for use with Avey and Leland-Gifford high-speed drilling machines, is shown in the accompanying illustration. This attachment has recently been brought out by E. L. Krag & Co., 50 W. Randolph St., Chicago, Ill. It is provided with a V-block to enable the drilling of holes for cotter-pins, etc., up to 3/16 inch in round, square, or hexagonal stock of various sizes up to 1 inch in diameter or across flats. More elaborate holders can be provided for indexing work to suit the drilling of two or more holes, or for cross- or end-drilling regular or irregular shaped pieces. The jig is operated through a foot-pedal, the work being clamped, drilled, and ejected by a forward movement of the pedal. The drilled work is removed by hand and a new piece inserted during the backward movement of the foot. By thus working the hands and one foot in unison, high rates of production are secured. All parts of the jig are accessible and readily adjusted for any size or length of stock within the capacity of the device. Lubricant is supplied to the point of the drill.



Drill Jig sold by E. L. Krag & Co.

NEW MACHINERY AND TOOLS NOTES

Sheet-heating Furnace: Electric Furnace Co., Alliance, Ohio. A portable resistance-type electric furnace used in the heating of sheet metal for forming automobile body parts and fenders. The hearth is 3 feet 4 inches wide and 6 feet 5 inches long. The furnace can heat 750 pounds of material per hour to a temperature of 1800 degrees F.

Tap-holder: Apex Machine Co., Dayton, Ohio. A friction-slip tap-holder which permits slippage within the holder itself in case a tap becomes wedged or strikes the bottom of a hole. It is thus particularly suitable for tapping blind holes. The holder is made in two sizes, one of which will hold taps up to and including ½ inch in diameter, while the other holds taps from ¼ to ¾ inch in diameter.

Drill Chuck: American Equipment Co., 5928 Second Boulevard, Detroit, Michigan. A slip-collet drill chuck which permits the rapid insertion or removal of the tool while the machine spindle is running. Drills, reamers, counterbores, and taps may be held in the collets. Two driving keys prevent crowding to one side and give a balanced drive in either direction so that the chuck is suitable for tapping operations.

Burning-in and Running-in Machine: Theodore W. Jansen Machine Co., 739 Twenty-first St., Des Moines, Ia. A burning-in, running-in and testing-out machine developed for use in the repairing of automobile engines. It will hold all types of engines without special blocking or fixtures. The work is mounted on the stand by securing it at each end to pivoted holders so that it can be rotated about its crankshaft and held in any desired position.

Cylinder Reboring Tool: International Purchasing & Engineering Co., Inc., 506 McKerchey Bldg., Detroit, Mich. A device which was originally intended for driving by hand or by means of a drilling machine, but which has now been fitted with an individual motor drive. The original type was described in May MACHINERY. The motor is mounted as a part of the tool and drives through a friction clutch which enables slippage in the event that the cutter-head becomes wedged.

Cylinder Reamers: New Britain Tool & Mfg. Co., New Britain, Conn. A set of expansion reamers for machining the cylinders of gas engines. It is intended that they be used in pairs for roughing and finishing. The pilot of the roughing reamer is ground to fit the normal bore of the cylinder and the cutting blades remove about 0.030 inch of stock. The pilot of the finishing reamer fits the bore left by the roughing reamer and its blades remove about 0.005 inch of metal.

Tool Grinding Machine: Wheeler Co., Railroad, Pa. A tool grinding machine provided with ball bearings for the spindle, countershaft and loose pulley. The head can be used on a bench or mounted on a pedestal. The countershaft is mounted at the rear of the pedestal and is provided with a shifter operated by a foot-pedal at the front of the machine. The head is made in two sizes, one for wheels 10 inches in diameter and 1½ inches thick, and the other for wheels from 12 to 14 inches in diameter and up to 2 inches in thickness.

Protractagraph: Turner Devices, Inc., 5 S. Newstead Ave., St. Louis, Mo. An instrument which is intended to take the place of such drafting tools as triangles, scales, and protractors, and which may be used with any parallel ruler attachment. It consists of a plate formed at its lower end into a semicircular protractor graduated in ½ degrees. Various scales and a transparent inking blade are easily attached to this plate. A knob on the axis of the device is used to revolve the scale. The instrument can be slid along the straightedge to place it in the desired positions on the drawing-board.

Surface Grinding Machine: William Osterhom, 2301 N. Knox Ave., Chicago, Ill. An automatic surface grinding machine intended for the grinding of surfaces up to 12 by 40 inches. The work is locked in a fixture which is mounted on a table pivoted about a swinging arm and moved past the surface of the abrasive wheel by means of a cam. Upon the completion of a cam cycle, the fixture is tilted 45 degrees away from the wheel to enable the operator to remove the work. The length of the swinging arm stroke may be varied from 2 to 24 inches. The feed of the wheel is automatically controlled by a cam.

Combination Lathe, Milling and Drilling Machine: Dalton Mfg. Co., Sound Beach, Conn. A combination machine especially designed for use in garages, etc. A single hollow spindle serves both the lathe and the milling equipment. The lathe and the milling equipment or the lathe and the drilling equipment may be used simultaneously. The lathe has a swing of 13 inches over the ways and by removing a section of the bed, a gap 6½ inches wide is obtained which will permit the handling of work 18½ inches in diameter. The milling table has a working surface of 24 by 7½ inches and a longitudinal feed of 15 inches in either direction. The transverse movement is 6¼ inches.

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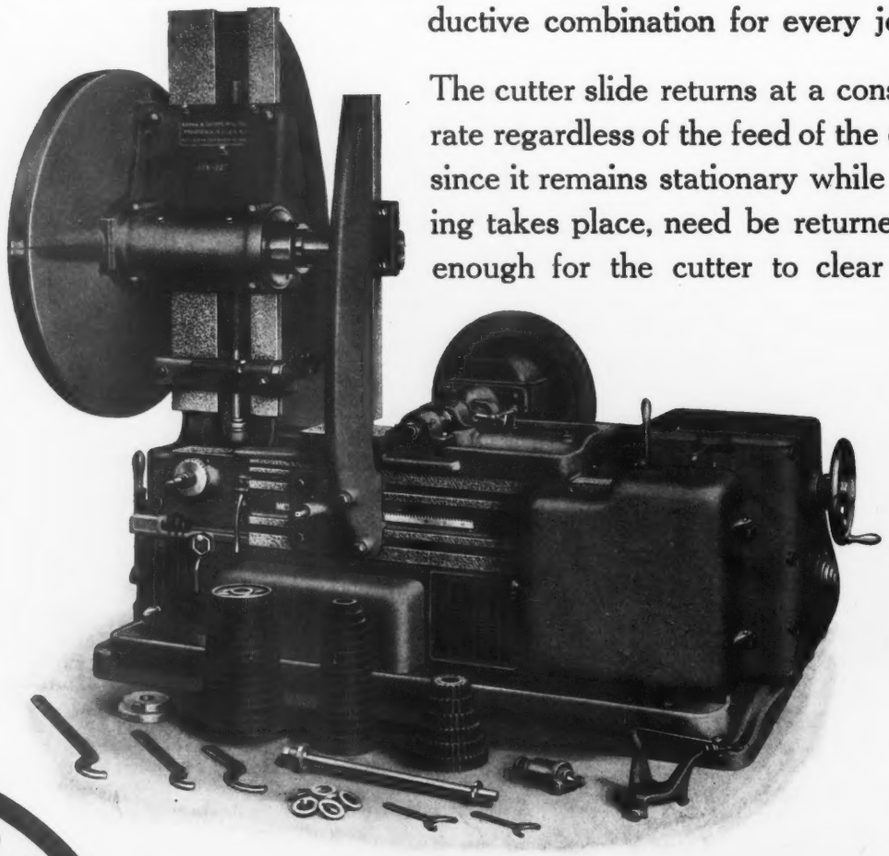
Possess the most vital factor

The numerous time saving features embodied in the design of these machines make them economical in setting up work as well as in their subsequent operation.

The handy control of these machines, due o the concentration of all operating levers, makes them particularly efficient and easy to operate. The complete separation of the cutter feeds and speeds is of great advantage, allowing the full range of feeds to be available for each cutter speed. This construction enables the operator to select the most productive combination for every job.

The cutter slide returns at a constant rapid rate regardless of the feed of the cutter, and, since it remains stationary while the indexing takes place, need be returned only far enough for the cutter to clear the work.



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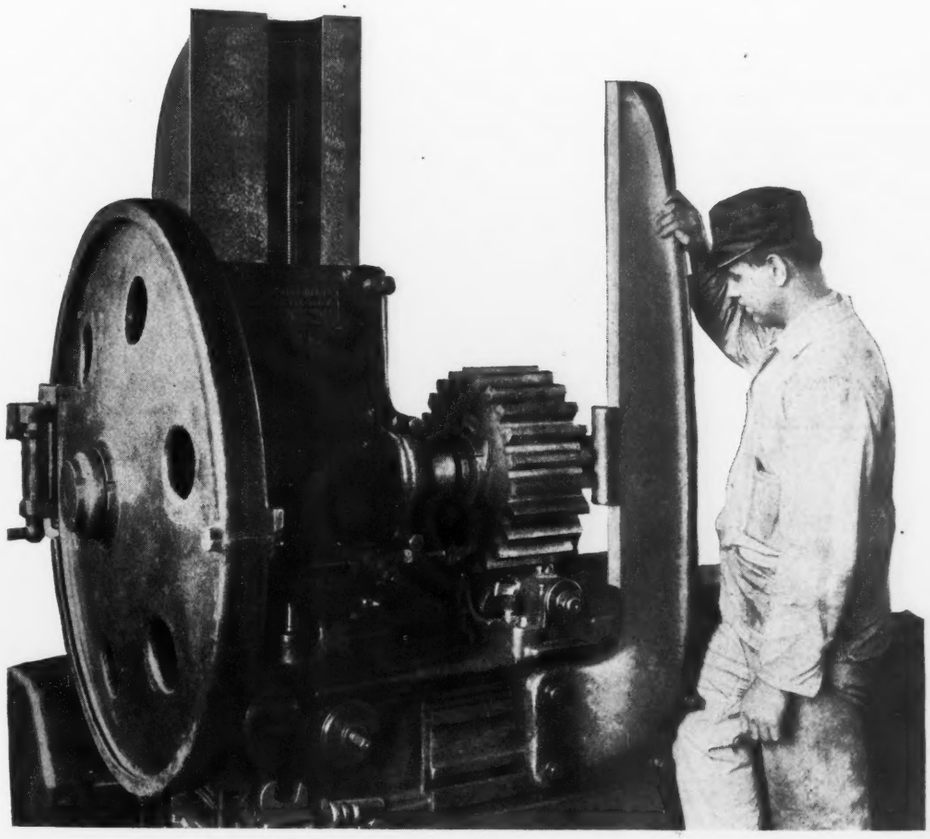
In addition, the indexing mechanism acts independently of the feed and speed of the cutter, resulting in a constant high speed in indexing. These features are all vital factors contained in Brown & Sharpe Automatic Gear Cutting Machines that save time in actual production.

Send for our General Catalog No. 137, listing our entire line of Spur and Bevel Gear Cutting Machines.



PROVIDENCE, R.I., U. S. A.

SPOKE NIPPLE DRILLING AND TAPPING MACHINE

The machine described in this article was especially designed and constructed by the Langelier Mfg. Co., Arlington, Cranston, R. I., for drilling and tapping in large quantities, cold-rolled steel nipples such as are used on the wire spokes of automobile wheels. The machine is semi-automatic in operation, five nipples being inserted by hand at a time into a row of steel bushings in the drum *A*. Aside from the loading of the drum the machine is automatic. The drum is mounted on the main shaft which extends through to the rear of the machine and there carries a stop-cam *B*, Fig. 3, to which there is attached on the inner side, a gear driven by another gear on the index-shaft *C*. This gear is enclosed by a suitable guard. The drum revolves intermittently, as determined by the index mechanism, to bring the work into position for loading, drilling, tap-drilling, tapping and ejecting the nipples. The first drilling head *D*, Figs. 1 and 2, carries the drills for producing clearance holes three-quarters through the nipples; the second head *E*, the tap-drills for finishing the holes; and head *F*, the taps. The knock-out arm is shown at *G*.

Main Drive and Safety Device

The driving side of the machine is shown in Fig. 2. The machine is belt-driven, and the flanged pulley transmits motion to the driving shaft by means of a friction clutch which is operated by the shipper rod *H*. This clutch must be engaged by hand, but may be disengaged either by an automatic safety device, or a foot-lever connected to this device. This foot-lever is not shown in the illustrations. For hand operation, lever *I* is employed to turn a segment gear which engages rack teeth cut on the under side of the shipper rod. The safety device for automatically disengaging the clutch is illustrated in Figs. 1 and 2 and its purpose is to instantly stop the machine whenever a nipple is improperly seated in a bushing. In case any of the five nipples which are simultaneously loaded into a row of bushings should project sufficiently to strike the arm *J*, the safety device would immediately operate. This arm, by means of its lever connections, moves a latch carried in slide *K*, which releases finger *L* on the shipper rod, and, with the aid of coil spring *M*, disengages the friction clutch and engages a multiple disk brake.

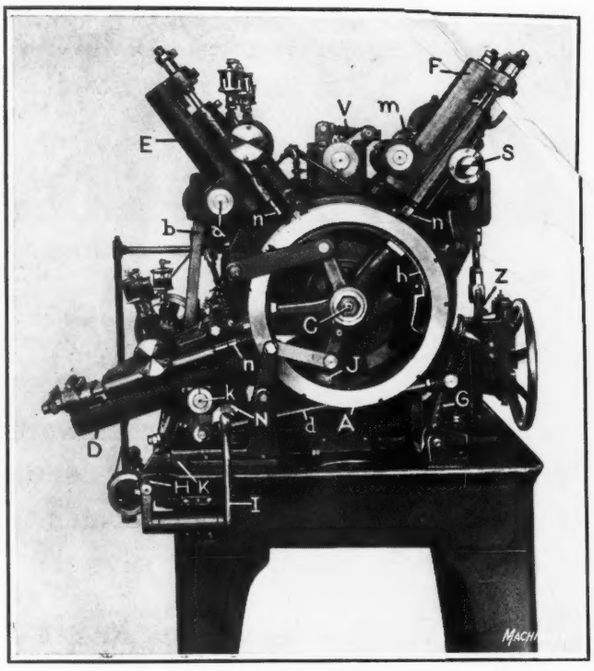


Fig. 1. Front View of Machine used for drilling and tapping Wire Wheel Spoke Nipples

Driving Mechanism for the Heads

The main shaft which carries the drum *A* and stop-cam *B* runs through a perforated cast-iron sleeve which is stationary and which provides the bearing for a large worm-wheel, on the hub of which the indexing- and feeding-cams are fixed. The driving shaft carries a bakelite gear *N*, Fig. 2, (also shown in Fig. 1) for driving the drilling head shaft *O* by means of a pinion, and the tap-drilling head shaft *P* by means of a belt. The driving shaft also carries a bevel pinion *Q* for driving a cross-shaft that extends through the machine at the rear, and at the opposite side (see Fig. 3) drives the tapping head *F* by means of suitable bevel gearing. This cross-shaft projects at *R* sufficiently to allow a handwheel to be assembled, this handwheel being the means provided for turning the rotative parts by hand, when so desired. Shafts *O* and *P*, Fig. 2, as well as a similar shaft *S* for the tapping head (see also Fig. 3) carry suitable spiral gears for driving the five spindles in their respective heads. It will be noticed also that shaft *O* has a flanged pulley belted to the pulley of the lubricant pump, and that this lubricant pump is piped direct to the three heads. This is more clearly shown in Fig. 1.

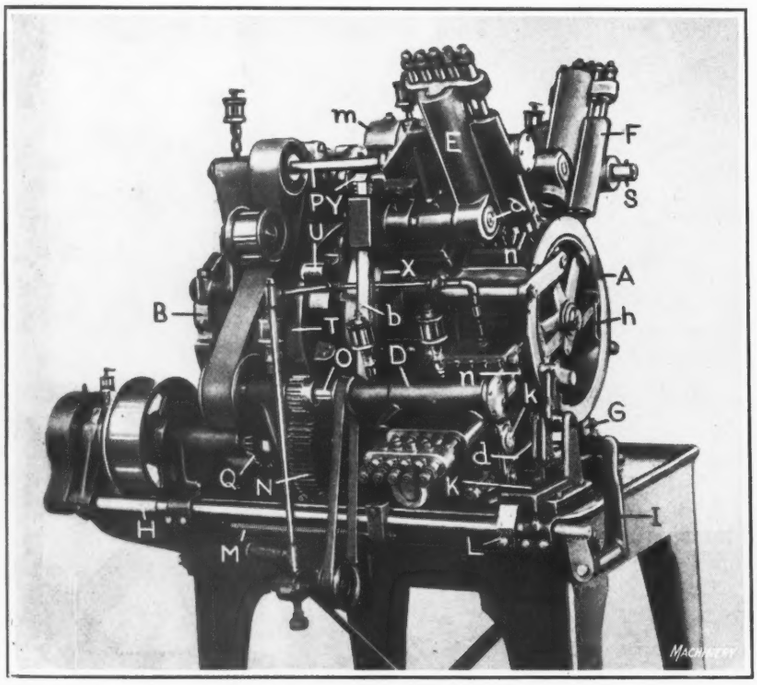
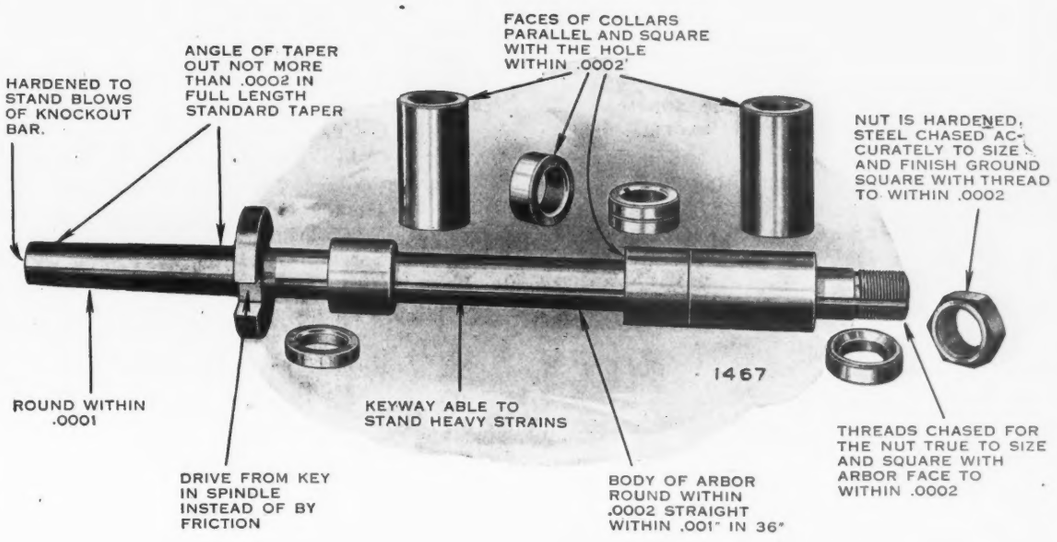


Fig. 2. Driving Side of the Machine shown in Fig. 1

Indexing and Feeding Arrangement

The cross-shaft *R*, Fig. 3, carries a worm located just back of and above shaft *C*, and this worm drives the aforementioned large worm-wheel mounted on the perforated cast-iron sleeve through which the main shaft of the machine operates. This worm-wheel with the index-cam *T* and the feed-cam *X*, Figs. 2 and 3, revolves as a unit on the stationary cast-iron sleeve. The index-cam carries a single gear tooth *U*, Fig. 2, on its side, so that as the cam is revolved a five-tooth index-pinion located directly beneath it on a short shaft will be intermittently revolved part of a revolution with each complete revolution of the index-cam. The short-index shaft carrying this five-tooth pinion extends to the rear of the machine, being the one previously mentioned and

Better Milling Machine Arbors


HARDENED TO STAND BLOWS OF KNOCKOUT BAR.
ANGLE OF TAPER OUT NOT MORE THAN .0002 IN FULL LENGTH STANDARD TAPER
FACES OF COLLARS PARALLEL AND SQUARE WITH THE HOLE WITHIN .0002'
NUT IS HARDENED, STEEL CHASED ACCURATELY TO SIZE AND FINISH GROUND SQUARE WITH THREAD TO WITHIN .0002
1467
ROUND WITHIN .0001
KEYWAY ABLE TO STAND HEAVY STRAINS
DRIVE FROM KEY IN SPINDLE INSTEAD OF BY FRICTION
BODY OF ARBOR ROUND WITHIN .0002 STRAIGHT WITHIN .001" IN 36"
THREADS CHASED FOR THE NUT TRUE TO SIZE AND SQUARE WITH ARBOR FACE TO WITHIN .0002

You cannot afford to make your own arbors, because you do not have the special equipment needed to make them accurately. An inaccurate arbor will not run true, and a few teeth in the cutter must do all of the work.

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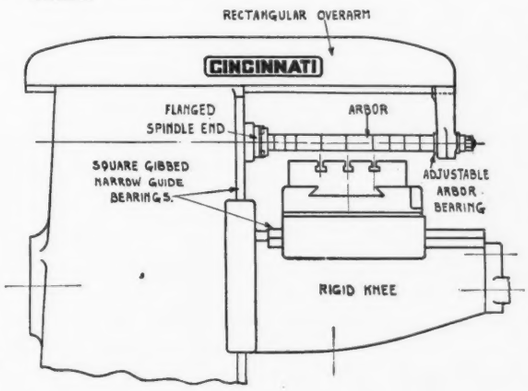
The *Flanged Spindle*—for driving.

The *Rectangular Overarm*—for proper support.

The *Adjustable Bearing*—for a snug fit.

The *Large Knee*—to carry the load.

The *Square Gibbed, Narrow Guide Bearings*—for rigidity and alignment.



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indicated at *C*, Fig. 3. With every movement of the five-tooth pinion it is evident that the stop-cam *B* will be revolved, turning the drum *A* at the front of the machine, as required to index it from station to station during the operation of the three multiple heads. The notched stop-cam *B* is temporarily locked in position by a steel toe carried in slubber arm *W*, this steel toe engaging with inserted steel cradles in the stop-cam. The synchronization of the movement of this arm with the indexing movement is accomplished by a roll that runs in a cam groove in the side of the index-cam, the movement being assisted by coil spring *V*, Figs. 1 and 3, directly above the shaft which carries slubber arm *W*.

Located slightly to the front of the index-cam on the worm-wheel hub is the feed-cam *X*, Figs. 2 and 3. This feed-cam has two cam grooves, one for radially operating the short rack *Y*, Fig. 2, and the other for operating a rack on the opposite side of the machine, shown in Fig. 3 at *Z*. The first of these racks meshes with a double spur gear for the purpose of revolving the tap-drilling head feed-shaft *a*,

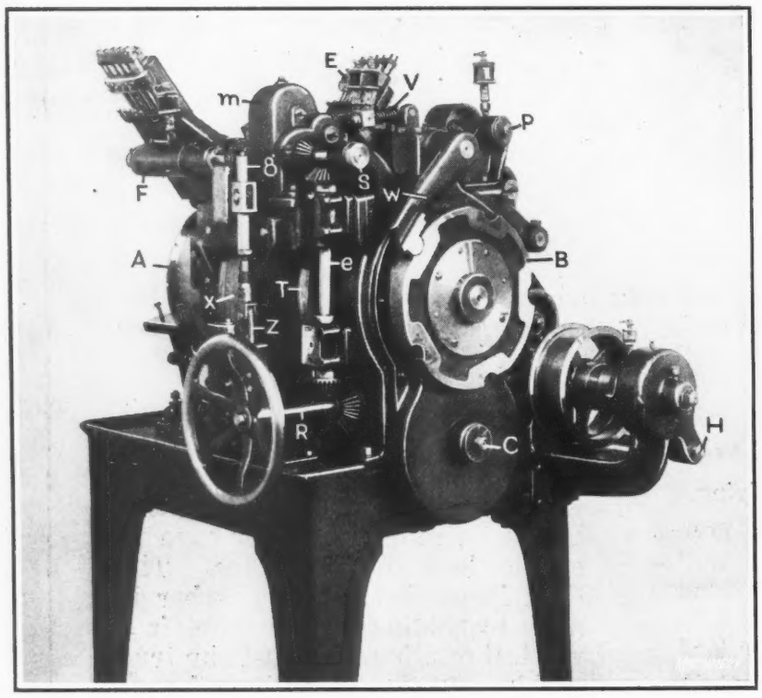


Fig. 3. View from the Rear showing Indexing Cam and Tapping Head Drive

Figs. 1 and 2 and for operating the vertical rack *b*. The teeth at the lower end of this rack mesh with a spur gear on the drilling head feed-shaft *k*, so that the feed movement for both heads *D* and *E* is controlled from one groove in the feed-cam. The spindle feed for the two heads is obtained by a spur gear and rack contained within each head. The drill-head feed-shaft *k* carries a finger at its front end so that as the feed is transmitted to the drill-head, the knock-out rod *d* will rock the arm *G* in which the knock-out pins are carried, and so dislodge the finished work from the bushings before the next index movement of the drum.

The other cam groove on the feed-cam controls the vertical movement of rack *Z*, Figs. 1 and 3, by means of which the reversal of the tapping-head shaft *S* is accomplished. The vertical bevel gear shaft *e* drives one end of this shaft, the other end being connected in gear-box *n* by a specially designed gear-and-segment reversing mechanism which is alternately shifted by post *g* as the rack *Z* moves up and down. The provision for changing the gearing of this reversing mechanism is the only means required for altering the feed of the taps, the mechanism being provided with change-gears so that it may be set up to furnish the correct speed to follow the lead of the tap that is employed.

Other Details of Construction

The feed-cam also carries a lug at its periphery for releasing the locking mechanism for drum *A*. This mechanism is located beneath the bed of the machine and consists of a lever hung at one end so that it can be pushed down by the cam lug, causing the opposite end of the lever to release a V-shaped detent from engagement with the drum. The drum *A* is provided with a hardened and ground steel spider *h* Figs. 1 and 2, which is held stationary by an arm so that as the drum revolves the ends of the nipples which project from the inside of the drill bushings will ride nicely over this spider and furnish the thrust backing for the drills and taps during the performance of the various operations. It will be seen that the spider is so fashioned that when the nipples are knocked out they will be prevented from dropping down to the lower part of the drum and thus will not interfere with the loading of the bushings. All the drilling and tapping spindles of this machine are provided with radial ball bearings as well as ball thrust bearings for the feed movement. The tools have straight shanks and are carried in split collets. They are driven by tangs ground on their shanks so that as the collets are pinched together by nuts *m* the tools will be securely chucked. The output of this machine is twenty drilled and tapped nipples per minute.

* * *

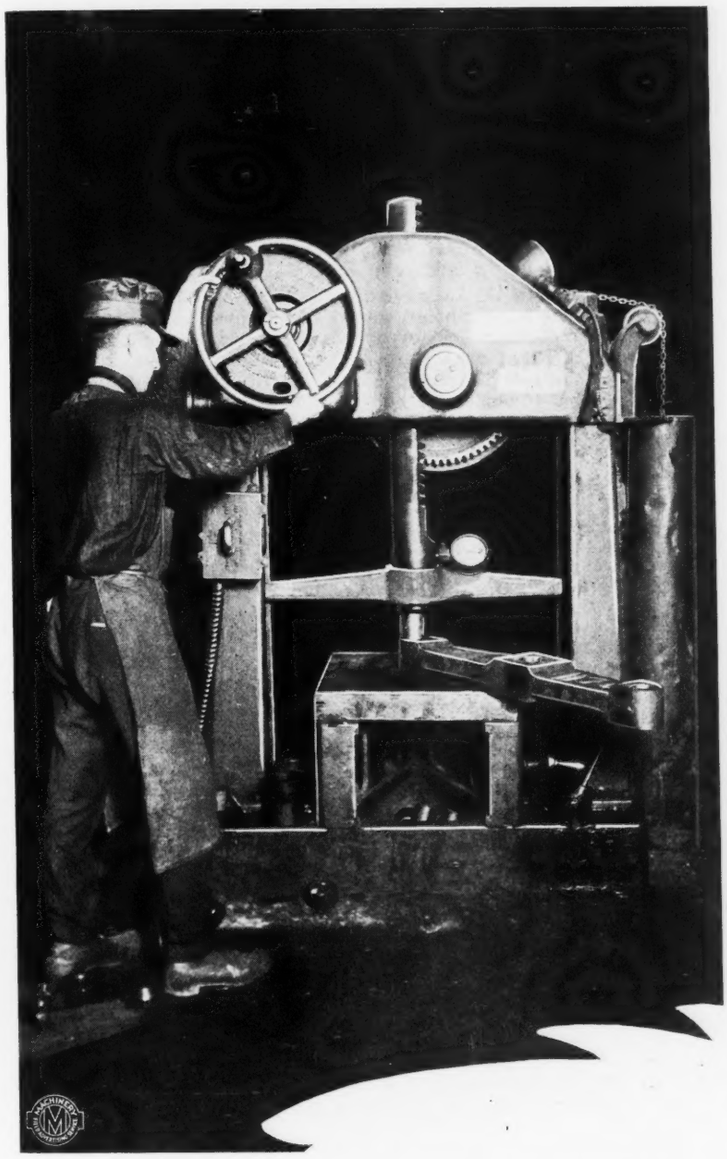
REVIEW OF INDUSTRIAL CONDITIONS

A general review of the main industries of the country shows the greatest activity in the textile field, especially in New England. The woolen and worsted mills are operating at the rate of from 75 to 100 per cent capacity, and the cotton mills at about 75 per cent capacity. An improvement is noted in the New England shoe factories, which have steadily gained until they were working up to 60 per cent of full capacity on July 1, with operations continually being expanded. Business in the retail field is from 10 to 20 per cent in physical volume of goods over the business done for the corresponding month last year, although, on account of reduced prices, the business in dollars and cents is slightly less than it was a year ago.

Improvements in railway traffic is indicated by the report of the American Railway Association, which shows that a gradual increase in the number of loaded freight cars. The reports for June, covering 144 railroads, also show that the net operating income of these roads amounted to over $48,000,000, as compared with a deficit of $10,600,000 on the same roads during the corresponding month last year. The total operating expenses in June, 1920, were $220,000,000, while in June, 1921, they were only $171,000,000, which accounts for the improvement in the net revenue. As the railroads are not yet operated to full capacity, it may be expected that when their operating revenue rises to a normal level, the net income will be further improved. The removal of the taxes on transportation provided for by the new revenue bill will doubtless help to stimulate traffic, particularly if the railroads themselves, in view of their improved financial condition, find themselves able to reduce the present high rates and fares.

* * *

Out of a total of 19,106 locomotives in good condition before the war, there are at present in Russia from 5500 to 7500 locomotives reported in working order. This represents a decrease of motive power of about 66 2/3 per cent. Of this number of locomotives, approximately 1000 are idle owing to lack of fuel.



A LUCAS

Power Forcing Press at Work in the D L & W's Scranton Shop

There are two of these simple and effective machines in this busy railroad shop—one a 30-ton press, the other with 50 tons capacity. The oldest has been in use for five years and both are giving excellent satisfaction.

The operation shown is forcing a bushing 4" long by 2½" diameter into a locomotive hanger forging to be used in brake rigging, and is readily accomplished with 3 to 4 tons of pressure.

The sphere of the Lucas Power Forcing Press covers that big tract of "no man's land" where the hand or screw press is too small and the hydraulic too large to work to advantage.

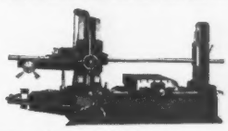
Control and adjustments center in the wheel, which automatically applies power when the ram meets with the resistance of the work. Action is rapid and positive.

Power is obtained from a worm-wheel on the pulley shaft through a friction clutch and is transmitted to the ram by means of gearing controlled by the handwheel.

No valves to leak—no pipes to freeze—no packing to renew. "A good all-around tool" is the verdict on this machine wherever it is installed, whether for bending, straightening, forcing, marking, forming or broaching and new uses develop for it every day.

WE ALSO MAKE THE

"PRECISION"



BORING, DRILLING AND MILLING MACHINE

Illustrated Circular tells the whole story.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert Brussels. Aux Forges de Vulcain, Paris. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

PERSONALS

FRANK A. POWER, for the last fifteen years with the Garvin Machine Co., New York, has resigned as sales manager.

LYMAN M. WAITE, formerly of the National Acme Co., and recently with the Springfield Automatic Screw Machine Corporation of Fitchburg, Mass., has been appointed sales manager of the Garvin Machine Co., New York City.

RALPH C. SCHWARZ has taken over the northwestern New York territory for the distribution and sale of Stewart industrial furnaces and appliances, made by the Chicago Flexible Shaft Co., Chicago, Ill. Mr. Schwarz will be located at 921 Granite Bldg., Rochester, N. Y.

HERMAN VOGES, JR., has resigned as president of the Webster & Perks Tool Co., Springfield, Ohio, in order to take a much needed rest from business. He has been continuously connected with the Webster & Perks Tool Co. for nearly thirty years, and has served in practically all capacities with that company. He will remain as a director of the company.

CLARENCE H. LANDSITTEL, for three years director of purchases for the Templar Motors Co., Cleveland, Ohio, and prior to that director of purchases for the Haynes Automobile Co., Kokomo, Ind., has become associated with the Climax Motor Devices of Chagrin Falls, Ohio, in the capacity of sales engineer. This company manufactures magneto and generator couplings.

ALEXANDER GABAY, formerly tool and efficiency engineer for the Western States Machine Co., Salt Lake City, Utah, is now production manager and assistant superintendent with the Baird Lock Co., Chicago, Ill., manufacturer of locking devices and non-pickable cylinder locks. Mr. Gabay, before he came to the Western States Machine Co., was connected with the Cincinnati Milling Machine Co., Cincinnati.

ROBERT B. MOIR has been appointed manager of the New York branch of the W. A. Jones Foundry & Machine Co., 4401-4451 W. Roosevelt Road, Chicago, Ill. Mr. Moir will assume his new duties immediately, making his headquarters at the present sales office and transmission warehouse of the company at 20 Murray St., New York City. Mr. Moir has been actively connected with the home office and factory of the company for a number of years, and is well qualified to assist in power transmission and general engineering problems.

JULIUS KLEIN, who was appointed by the President as Director of the Bureau of Foreign and Domestic Commerce, to fill the position made vacant some time ago by the resignation of R. S. MACELWEE, has assumed his duties. Dr. Klein first came to the bureau in September, 1917, as chief of the Latin-American Division. He remained in that capacity until May, 1919, when he was made commercial attaché to the Department at Buenos Aires, Argentina. He resigned from his position in October, 1920. Dr. Klein has specialized in Latin-American economics and trade.

WALTER H. RASTALL has been appointed by Secretary Hoover chief of a new division in the Department of Commerce, which has been especially created to give attention to the foreign trade in industrial machinery; this is one of the new divisions provided for by Congress in making appropriations under the recent Export Industries Act. It is the plan of this division to cooperate with American manufacturers and exporters of factory machinery, and to take such steps as may be possible for a government department to assist manufacturers in solving their foreign trade problems. Mr. Rastall has had extensive experience, both in domestic and in foreign trade, and has spent nine years in the sale of machinery in Asia, from where he has recently returned after an investigation of the machinery markets in that part of the world. He is a graduate of Cornell University and a mechanical engineer.

ARTHUR H. ADAMS, for twenty years active in the manufacture of telephone and telegraph apparatus, is opening offices on October 1 for consulting work at 41 Park Row, New York City. Mr. Adams was for some years superintendent of the Bell Telephone Mfg. Co. of Antwerp, Belgium, during which time he was called upon to inspect in a consulting capacity a number of European plants; he has since done development and design work for the Western Electric Co., Inc.; and for the last three years has been successively factory superintendent and chief engineer of the North Electric Mfg. Co. of Galion, Ohio. He has developed and patented several special machines in these years, including rotary thread-rolling, coil-winding, braiding and telephone switching machinery, as well as printing telegraphs. He will specialize in the field of lighter mechanics, with special emphasis on the coordination of design with manufacturing equipment.

* * *

STATISTICS OF THE AUTOMOBILE INDUSTRY

In a pamphlet recently published by Leonard P. Ayres, vice-president of the Cleveland Trust Co., Cleveland, Ohio, some interesting statistics are given relating to the automobile industry and its future. Since the beginning of the automobile industry in America twenty-five years ago, the number of cars manufactured up to January, 1921, was 11,775,000, of which more than 700,000 were imported. About 9,000,000 cars are in use in the United States, 2,000,000 having been worn out or destroyed by accidents. The average length of life of an automobile is estimated at about six years. At the end of 1920 there was approximately one car to every twelve persons in the United States. If, instead of considering the entire population, the basis for comparison is the number of white, native born men above the age of 21, it will be found that there are 42 cars in the United States to every 100 men. The number varies in the different parts of the country from about 22 cars to 100 men in the South Central States to 60 cars per 100 men in the Pacific States.

COMING EVENTS

September 7-28—Shipping, Engineering and Machinery Exhibition, Olympia, London, W., England. General Manager, Frederic W. Bridges, 36-38 Whitefriars St., Fleet St., London, E.C.4.

September 12-17—Fall meeting of the American Institute of Mining and Metallurgical Engineers in Wilkesbarre, Pa. Secretary, Bradley Staughton, 29 W. 39th St., New York City.

September 14-16—Annual convention of the National Association of Cost Accountants in Cleveland, Ohio; headquarters, Hotel Cleveland. Secretary's address, 233 Woolworth Bldg., New York City.

September 19-24—Third annual convention and exhibition of the American Society for Steel Treating in Indianapolis, Ind. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

September 28-October 8—New York Electrical Exposition at the 71st Regiment Armory, Park Ave. and 34th St., New York City. For information relating to exhibits, apply to Norman Maul, the Electrical Show Co., 130 E. 15th St., New York City, Room 828.

October 3-4—Regional meeting of the American Society of Mechanical Engineers in Cleveland, Ohio; headquarters, Hotel Winton.

October 5-6—Twelfth annual convention of the American Manufacturers' Export Association in New York City; headquarters, Waldorf-Astoria Hotel. Secretary, A. W. Willmann, 160 Broadway, New York City.

October 5-7—Fall meeting of the Society of Industrial Engineers in Springfield, Mass.

October 17-22—Twenty-fourth annual convention of the American Mining Congress in the Coliseum, Chicago, Ill. In conjunction with the convention there will also be a national exposition of mines and mining equipment.

October 17-22—Twenty-seventh annual convention of the National Hardware Association of the United States in Atlantic City, N. J.; headquarters, Marlborough-Blenheim Hotel, Secretary, T. James Fernley, 120 High St., Boston, Mass.

October 17-22—National exposition of mines and mining equipment in Chicago, Ill., under the auspices of the American Mining Congress, Washington, D. C.

October 18-20—Annual convention of the National Machine Tool Builders' Association in New York City; headquarters, Hotel Astor. General Manager, Ernest F. DuBrul, 817 Provident Bank Bldg., Cincinnati, Ohio.

November 4-5—Regional meeting of the American Society of Mechanical Engineers in Kansas City, Mo.

December 1-3—Fall meeting of the Taylor Society in New York City. Secretary, Harlow S. Pearson, 29 W. 39th St., New York City.

May 8-11, 1922—Spring meeting of the American Society of Mechanical Engineers in Atlanta, Ga. Assistant Secretary (Meetings), C. E. Davies, 29 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

Michigan College of Mines, Houghton, Mich. Year book for 1920-1921, containing calendar and announcement of courses for 1921-1922.

University of Nebraska, Lincoln, Neb. Fifty-first annual general catalogue, containing announcements for 1921-1922, an outline of the various courses offered, and general information.

NEW BOOKS AND PAMPHLETS

Wages in the United States and Foreign Countries. 103 pages, 6 by 9 inches. Published by the Government Printing Office, Washington, D. C.

This book, copies of which may be obtained free by addressing a request to the Ways and Means Committee, House of Representatives, Washington, D. C., has been prepared for the use of the Committee on Ways and Means of the House in connection with pending tariff legislation. It covers, mainly, wages paid in the United States, Germany, Japan, England, France, Belgium, and Italy. The sources of information are furnished in each case, so that the reader may judge for himself as to the authoritativeness of the figures presented. Often the figures quoted are given in the United States currency, which is somewhat unsatisfactory, because the rate of exchange upon which the conversion has been based is not stated. In many instances, however, the wages are given in foreign currency, which is far more satisfactory because the corresponding figure in United States currency can then easily be obtained by using the current rate of exchange. The book is somewhat misleading for present use, because in many cases it reports wages in the United States for that period of 1920 when they were at their high peak, and in the general resume of wages for ten selected industries in seven of the leading countries, no statement is made of the year when these wages

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Electrical Work, Calculating Machines, Automatic Machines of all kinds, Typewriters, Adding Machines, Knitting and Weaving Machinery, Carpet Sweepers, Vacuum Cleaners, Mechanical Toys, for Dental and Surgical Work, in fact anywhere where a positively safe and perfect wire must be used.

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If your springs are made on the outside it will be to your advantage *to insist* they be made of "F & G" wire.

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were paid. Hence it is difficult to determine the value of the figures given, particularly for the important work of tariff legislation. If Congress bases its work upon 1920 wages, or wages in July and August, 1920, as given in some instances, the figures will be from 15 to 25 per cent higher than present wage rates in most industries.

NEW CATALOGUES AND CIRCULARS

Bausch & Lomb Optical Co., Rochester, N. Y. Circular descriptive of the Bausch & Lomb stereoscopic eye-piece, for use with monocular microscopes.

Pawling & Harnischfeger Co., 38th and National Aves., Milwaukee, Wis. Pamphlet TX, illustrating and describing the new Skimmer scoop attachment for P & H Types 205 and 206 excavator cranes.

New Departure Mfg. Co., Bristol, Conn. Loose-leaf data sheets, 134, 135, and 136 FE, containing illustrations and descriptions of ball bearings in a hydraulic dynamometer, pneumatic grinder, and steam turbine.

Bell & Gossett Co., 609 W. 30th St., Chicago, Ill. Circular folder advertising "Caseite," a hardening material for use in the cyanide process. Also circular giving dimensions and weight of carbonizing boxes and cyanide pots.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1033-A containing data on direct- and alternating-current automatic pressure regulators. Bulletin 1042-C illustrating and describing E. C. & M. automatic compensators for alternating-current squirrel-cage motors.

Union Switch & Signal Co., Swissvale, Pa. Folder entitled "Drop-forgings" illustrating types of drop-forgings made by the company for trucks and tractors, including axles, crankshafts, camshafts, connecting-rods, steering knuckles, gear blanks and pinions, crank and gear-case covers, etc.

Electric Dynamic Co., Bayonne, N. J. Bulletin 300, showing pictures of the facilities of the company's factory for producing electrical machinery. The illustrations show electric motors in process of manufacture ranging in size from ½ to 1000 horsepower, both for alternating and direct current.

H. D. Smith & Co., Plantsville, Conn. Circular illustrating and describing the "Perfect Handle" tool kit, comprising three different sizes of screw-drivers, tire tool or pry bar, hammer, standard wrench, pipe wrench, monkey-wrench, regular punch, nail punch, cold chisel, and offset slip joint pliers.

Hart Roller Bearing Co., Orange, N. J. Pamphlet on "Increasing Production," containing a discussion of the application of roller bearings in machinery, and the possibility of increasing production through their use. The construction of Hart staggered roller bearings is illustrated and described.

Pierce, Butler & Pierce Mfg. Corporation, 437 E. 162nd St., New York City. Catalogue of Pierce packless valves, illustrating and describing valves for different purposes manufactured by the company, and also putting forth briefly some of the underlying facts that determine the serviceability of valves.

Goddard & Goddard Co., Detroit, Mich. Leaflet No. 1, entitled "Real Production Tools" illustrating and describing the "Go and Go" half side mill. The advantages claimed for the design and construction are clearly set forth, and the possible saving by the use of these cutters specifically pointed out.

Medart Patent Pulley Co., St. Louis, Mo., manufacturer of complete lineshafting equipment, including shafting, couplings, bearings, hangers, pulleys, friction clutches, belt tighteners, rope drives, gearing, sprockets, etc., is issuing a monthly publication known as "The Dart," containing matter relating to the personnel, methods, equipment, and products of the company.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Catalogue containing 40 pages, 8½ by 11 inches, descriptive of Cutler-Hammer elevator controllers and accessories. A discussion of the types of motors best suited to elevator work is presented, as well as an outline of the usual method of selecting motors of the right horsepower and starting torque to insure satisfactory performance.

Sterling Grinding Wheel Co., Tiffin, Ohio. Circular describing the application of "Sterbon" grinding wheels in foundry practice, and for cylindrical grinding, internal grinding, and surface and edge grinding. The circular also gives a grading table for "Sterbon" wheels, which specifies the grain and grade of wheels to be used for different classes of materials and various operations.

George Cutter Works of the Westinghouse Electric & Mfg. Co., South Bend, Ind. Booklet containing wiring tables and illuminating data relating to the problems of wiring and lighting offices, factories, etc. Tables of foot-candle intensities recommended for different classes of service are included, as well as a discussion of lighting installations. Lighting accessories, such as reflectors, fixtures, hangers, plugs, and receptacles are shown.

Bastian-Blessing Co., 125 W. Austin Ave., Chicago, Ill. Catalogue 23, containing data relative to "Rego" welding and cutting apparatus, including welding and cutting torches, manifolds, welding and cutting regulators, cutting, welding, and soldering outfits, adapters, nipples and fittings, wrenches, etc. A number of new products are shown in this catalogue, and some of the prices have been revised. Copies of the book will be sent upon request.

Diamant Tool & Mfg. Co., Inc., 91-97 Runyon St., Newark, N. J. Catalogue describing Diamant standard punch and die sets, the unit parts of which are made on an interchangeable basis, thus giving an opportunity to select from a wide variety of sets different combinations to suit the parts to be produced. Tables are included giving the capacities and dimensions of the different sets, the standard parts being designated by letters on the accompanying diagrams.

Boston Gear Works, Norfolk Downs (Quincy), Mass. 1921 edition of general catalogue G1, covering 600,000 standardized Boston gears, carried in stock in 1500 sizes. A list of additions to the stock sizes is given on page 4. Complete data including dimensions, prices, etc., are given for brass, iron, and steel bevel and spur gears, worm-gears, sprockets, etc. The booklet also shows ball bearings, steel bushings, gear gages, pulleys, racks, and universal joints.

W. S. Rockwell Co., 50 Church St., New York City. Bulletin entitled "Selection of Fuels," containing a series of papers relating to the selection and use of fuels and equipment for industrial heating operations. The bulletin contains five specific papers, as follows: Factors Governing the Selection of Fuels; Comparative Fuel Prices on B. T. U. Basis; Comparative Heating Value of Industrial Fuel Gases; Composition of Industrial Fuel Gases; and the Utilization of Fuel Resources.

Nazel Engineering Works, 4043 N. 5th St., Philadelphia, Pa. Catalogue entitled "The Nazel Hammer Book," illustrating and describing in detail the construction, operating principle, motive power, and other features of the Nazel air hammer. The different types of hammers are illustrated, and complete specifications are given for each. A diagram of this type of hammer, with the various parts numbered and designated in the accompanying list, is included for the user's convenience in ordering repair parts.

Greenfield Tap & Die Corporation, Greenfield, Mass. New 400-page catalogue No. 46, describing the line of small tools and pipe tools made by this company. The tools shown include screw plates, taps, dies, drills, reamers, milling cutters, bits, arbors, countersinks, hobs, tap and drill kits, mandrels, sleeves, sockets, stocks, tap wrenches, pipe vises, and pipe wrenches. In addition to the descriptive material relative to the tools, seventy pages of tables and general information are included. A copy of the book will be sent to anyone who mentions MACHINERY.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Catalogue 9-C, illustrating and describing the new line of electric furnaces which has been added to the products of the company. The furnaces described include the multiple unit type, small "hevi-duty" furnaces, and "hevi-duty" industrial furnaces. Applications for annealing, hardening, drawing, and enameling are described. Special publication 1643, treating of the application of oil circuit-breakers, including an outline of the characteristics of the several types of Westinghouse oil-circuit breakers.

General Fireproofing Co., Youngstown, Ohio. Catalogue entitled "Saving with Shelving," containing illustrations of the different types of GF all-steel shelving and their application in storerooms, vaults, tool-rooms, libraries, and for a wide variety of uses. A complete list of sizes is included. This shelving is made on the unit principle, a few fundamental pieces forming a foundation from which may be developed installations of many sorts to handle various kinds of loads and materials. Catalogue entitled "Efficient Record Protection," containing illustrations and specifications covering the all-steel safes made by this company for the preservation of business records.

Heald Machine Co., Worcester, Mass., has published a book comprising a treatise on cylinder regrinding, the purpose of which is to assist those entering the business of regrinding automobile cylinders. The book contains 116 pages, 6 by 9 inches, and the material is divided into eight chapters. The first chapter deals with the field for cylinder regrinding, outlining the advantages and possibilities, and giving actual figures concerning the possible profits, as well as information on shops best adapted for regrinding, and where work of this kind can be obtained. The second chapter treats of the equipment required by an average shop for regrinding and fitting pistons, rings, and pins, and describes in detail Heald cylinder grinding machines. The third chapter discusses why motors should be reground, and the fourth chapter gives a number of kinks of value in regrinding work. The fifth chapter contains a detailed description of the operation of the Heald cylinder grinding machine. The sixth chapter covers advertising and publicity. The seventh chapter treats of assembling the motor and, though short, is considered very important, as many a regrinding operation is spoiled by improper assembling. The eighth chapter contains general information relating to the Heald line. The data contained in the book should be of considerable interest and value to those entering this field of work.

TRADE NOTES

Peter A. Frasse & Co., Inc., 417 Canal St., New York City, have been appointed sole agents for the Metropolitan district for Sibley drilling machines made by the Sibley Machine Co., South Bend, Ind.

Oxweld Acetylene Co., Newark, N. J., manufacturer of "Oxweld" welding and cutting equipment, has removed the offices of its foreign sales department from Newark to 30 E. 42nd St., New York City.

Tool-Bit Specialty Co., Syracuse, N. Y., has been organized to manufacture high-speed steel tool-bits. A full line of sizes will be carried in stock. The bits are made by the hammering process, it being claimed that this method produces a better bit than can be obtained by the rolling process.

Frostholm-Treiber Co., Rochester, N. Y., has been incorporated with a capital of $24,000 by C. C. and J. H. Frostholm and W. C. Treiber to manufacture tools, piston rings, and kindred products. For the present, correspondence should be addressed to Frostholm Bros., 221 Washington Square, Syracuse, N. Y.

Brown & Sharpe Mfg. Co., Providence, R. I., announces that its annual vacation, starting July 29, will be extended this year to September 6. During this time the stock-room and offices will remain open as usual, and essential operations will be carried on in the shop, so that satisfactory deliveries can be made on supplies and on any of the Brown & Sharpe standard products.

Garvin Machine Co., Spring and Varick Sts., New York City, manufacturer of milling machines, screw machines, and numerous other types of machine tools, announces the resignation of its sales manager Frank A. Power, and the appointment to this position of Lyman M. Waite, formerly with the National Acme Co. and recently with the Springfield Automatic Screw Machine Corporation of Fitchburg, Mass.

Webster & Perks Tool Co., Springfield, Ohio, has sold the grinding and polishing stand and accessory department of its business to the **Hill-Curtis Co.**, Kalamazoo, Mich. This change has been made in order that the company may concentrate all its facilities on the exclusive manufacture and sale of the W & P line of universal and plain cylindrical grinding machinery. The Hill-Curtis Co. is an established concern operating a foundry, forge, and machine shop, and is well equipped for manufacturing this line.

Dodge Sales & Engineering Co., Mishawaka, Ind., manufacturer of transmissions and heavy oil engines, announces that work on its new $1,000,000 building at 49 Park Place, New York City, has been started, the excavation being practically completed. Present plans call for a twelve-story building, but the foundation and construction will permit of an additional four stories, if needed. The new building will occupy 165 feet frontage on West Broadway, 50 feet on Murray St., and 75 feet on Park Place.

W. A. Jones Foundry & Machine Co., 4409 W. Roosevelt Road, Chicago, Ill., at a recent meeting elected T. A. Jones president of the company to succeed the late William A. Jones. The other officers elected are as follows: W. G. Jones, vice-president and treasurer; J. A. Sizer, secretary; and G. W. Page, assistant secretary. The general policy of the company is in no way altered by these changes and W. G. Jones continues to hold the position of general manager in addition to acting as vice-president and treasurer. T. A. Jones, the new president, has been associated with the company for many years as its secretary and treasurer.

Reeves Pulley Co., Columbus, Ind., announces that arrangements have been made with Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City, whereby the latter firm assumes the exclusive agency for the Reeves variable-speed transmission in the New York territory. Manning, Maxwell & Moore will carry a complete assortment of repair parts for these transmissions for immediate delivery. They will also carry a large stock of complete variable-speed transmissions of various sizes and types, and will have a completely organized variable-speed transmission department in charge of capable engineers. Manning, Maxwell & Moore will also handle and carry in stock the Reeves wood split pulley.